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ERRATA

Vol. 10, No. 1, January 1941: Note entitled "Production of Fruit-bodies of *Agariceus polyporus* Berk. in Artificial Culture", page 26, 2nd column in the heading of the note, *for* "*Agariceus polyporus* Berk." *read* "*Polyporus agariceus* Berk."; line 20 of the same note, *for* "Polyporus culture" *read* "Polysporus culture".

Vol. 10, No. 2, February 1941: With reference to figures illustrating Professor B. Sahni's article on "Yaudheya Coin Moulds from Sunet, near Ludhiana in the Sutlej Valley", pages 65–67, the correct numbering is as follows:—

1	2		
3	4	7	3
5	6	9	10
10*a*	11	11*a*	12

Vol. 10, No. 3, March 1941: P. 173, Note on "Chromatin Bridges in the Root Tip of Ground-nut", *insert* the following under Fig. 1:—"The fragment found along with the chromatin bridge".

Vol. 10, No. 4, April 1941: 1. Contribution entitled "Cinchona Cultivation in India", page 223, para 2, line 8, *for* "21,00 lbs." read "210,000 lbs." 2. Note entitled "Modified Equations for Adsorption and Base-Exchange in Soils", page 203, Table II, column 4, *for* $x = \frac{BU}{1+C'}$, *read* $x = \frac{BI}{1+C'}$. 3. Table II, column 5, the last but one value, *for* 1·123 *read* 1·213.

Vol. 10, No. 11, November 1941: Note entitled "Industrial Research Fund", page 483, second column, line 14, *for* "prominent" *read* "permanent".

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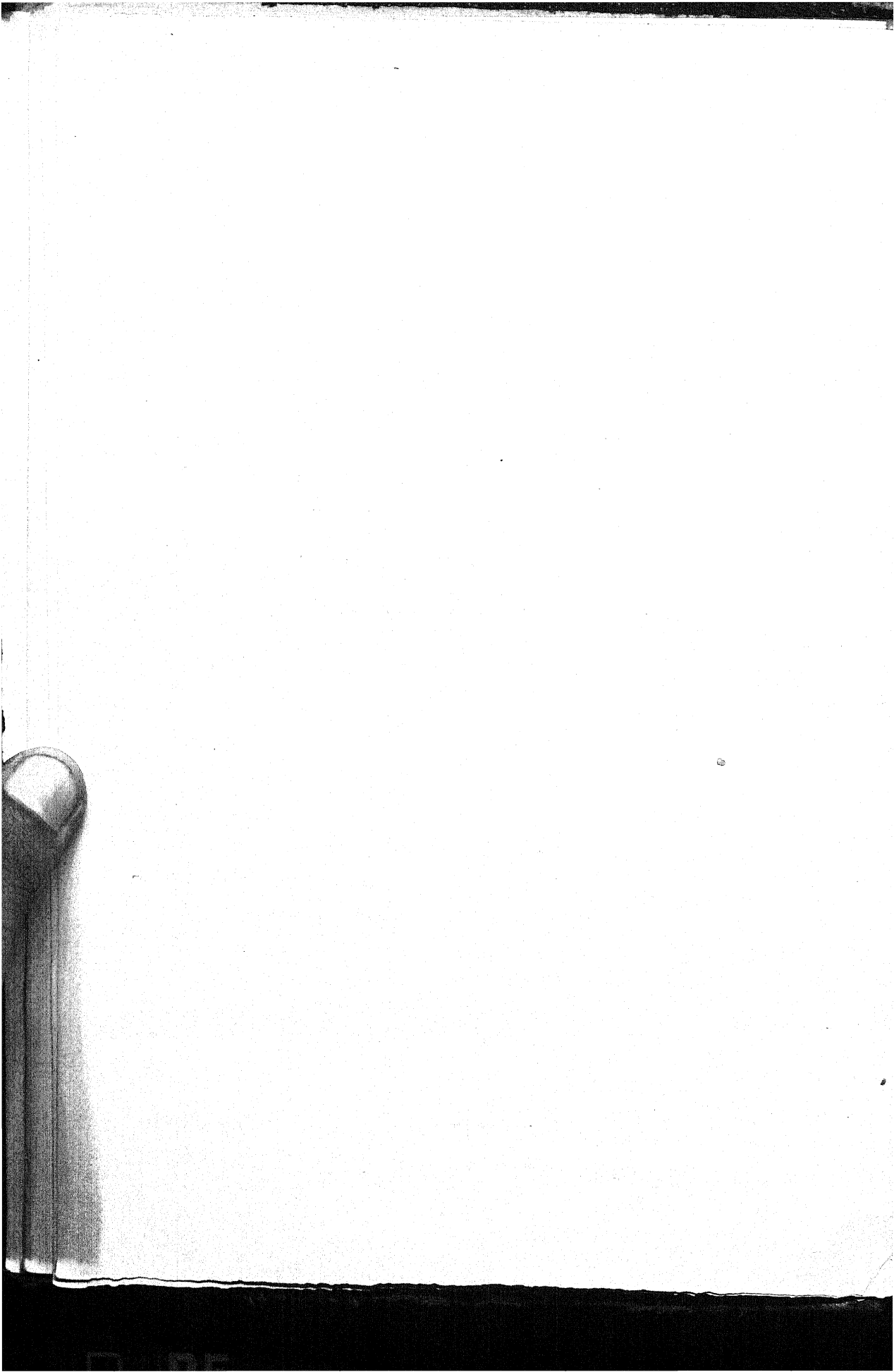

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SCIENCE AND INDUSTRY*

BY

SIR ARDESHIR DALAL

I FEEL that the authorities of the Indian Science Congress Association have made a very bold departure in electing a layman to the honour of the Presidentship for the year and, deeply conscious as I am of the honour, I confess to a feeling of diffidence in occupying a post which has been adorned by so many distinguished scientists before me. If my address falls short of the standard set by my predecessors, the responsibility of it should in part be borne by those who have elected me. The only reason for their choice, as far as I can see, lies in the fact that I may lay some claims to be an industrialist. So close and intimate is the relationship between science and industry and so strongly is that fact being brought home to us in these days that the Association felt perhaps that they would like to have the views of an industrialist on the relationship of science to industry with particular reference to the practical problems which have arisen in India since the beginning of the war. A substantial part of the export trade of India has been lost since the war. Science can help in the utilization within the country itself of some of the raw materials which used to be exported. Researches are being conducted for instance on the use in India for lubrication purposes of some of the oil seeds of which the export has dwindled down and the surplus of which is likely to create serious economic trouble for the cultivator. Even a more acute problem is the stoppage of the import of many commodities essential for the economic life of the country, such as machinery, chemicals, etc. It is imperative that India should make herself self-sufficient with regard to such materials as are vital to the maintenance of her economic and industrial life so that the situation which had arisen during the last War and which has arisen once again may never recur. It is here that science can be of the greatest assistance to industry. Research has been described as the mother of industry and while some of the older and more traditional industries may have originated without the aid of science, it cannot be denied that all industries to-day depend upon science and research not only for their progress and improvement but also for their survival. Sad experience has proved to us beyond all doubt that, under modern conditions, no nation, however peacefully inclined, can expect even to live an independent existence unless it is highly industrialized. It is the industrial potential that is convertible into the war potential and the country that has

* Presidential Address delivered at the Indian Science Congress, Benares, 1941.

the highest industrial potential and is prepared to convert it in the shortest time into war potential that stands the best chance in modern warfare. As we have seen, it is not man power that counts in the highly mechanized warfare of the present day, but planes, tanks, guns, ships and the factories, plants and workshops behind them. The lesson for India is plain and she can only neglect it at her peril. It is no longer the question of a balanced economy or of mere material progress. It is necessary for India's very existence that she should be highly industrialized.

This lesson was first taught during the last World War. Owing to its superior scientific organization and equipment Germany was able to withstand the Allies much longer than she could otherwise have done. At the beginning of that War, England found that she was deficient in many forms of optical glasses, dyestuffs, chemicals and other necessities for the conduct of modern warfare. She set herself to remedy these drawbacks. A very important dye industry was created and the whole of the scientific and research talent of the country was organized by the creation of the Department of Scientific and Industrial Research. It is not necessary for me to enter into the details of the organization and working of the D.S.I.R. with which many of you must be familiar. An interesting feature of the organization, however, to which the attention of the authorities in India needs to be drawn is that the administrative organization of the D.S.I.R. is entirely composed of technical men, while the Advisory Council, which guides and controls its activities, is mainly composed of distinguished scientists with the addition of two or three well-known industrialists and business men. The words of Lord Rutherford to the Twenty-fifth Indian Science Congress, though frequently quoted since then, will bear repetition as they have an important bearing on the policy of the Government of India towards the recently created Board of Scientific and Industrial Research. He said:

> 'In Great Britain, the responsibility for planning the programmes of research, even when the cost is borne directly by the Government, rests with research councils or committees who are not themselves State servants but distinguished representatives of pure science and industry. It is to be hoped that if any comparable organization is developed in India, there will be a proper representation of scientific men from the universities and corresponding institutions and also of the industries directly concerned. It is of the highest importance that the detailed planning of research should be left entirely in the hands of those who have the requisite specialized knowledge of the problems which require attack. In the British organizations there is no political atmosphere, but of course the responsibility for allocating the necessary funds ultimately rests with the Government.'

There has been a tendency in the past in India for scientific and research work to be monopolized by Government Departments and although valuable results have been obtained, *e.g.*, by the Survey of India, the Geological Survey, the Botanical Survey and in the investigation of tropical diseases, it is very necessary that organized industrial research should as far as possible be left to scientists and industrialists although of course Government has to see that the grants it makes are properly utilized.

Board of Scientific and Industrial Research

Industrial research was organized on a country-wide basis in America as well as in several countries of the British Empire following the lessons of the last War. In India also the War revealed the helplessness of the country. The transport service was disorganized owing to lack of railway material; supplies of dyes, important chemicals and many important medicines were almost completely stopped and prices of textiles shot up so high as to be beyond the means of poor people. In 1915 the Government of India addressed the Secretary of State as follows:—

> 'After the war India will consider herself entitled to demand the utmost help which the Government can afford to enable her to take a place, so far as circumstances permit, as a manufacturing country.'

This policy was accepted by the Secretary of State and the Indian Industrial Commission, under the Chairmanship of Sir Thomas Holland, was set up as a result. Unfortunately, however, the impetus to industrialization provided by the War died down after a few years and many of the industries which were started during the War languished and died. The gathering storm clouds of a new world war drew the attention of Indian scientists to the unorganized state of scientific and industrial research in India

and repeated appeals were made for the constitution of a body on the model of the D.S.I.R. The urgent need for the appointment of such a body was voiced by Professor J. C. Ghosh in his presidential address to the Association at Lahore in 1939 and was reiterated in a resolution of this body last year at Madras. The same point was made by Colonel Chopra in his presidential address to the National Institute of Sciences in Madras last year and by Sir M. Visvesvaraya in an address to the Indian Institute of Science, Bangalore. We, therefore, cordially welcome the recent appointment of the Board of Scientific and Industrial Research by the Government of India in response to the demand of scientists throughout the country. Our thanks are due to the present Commerce Member, Sir Ramaswami Mudaliar, who lost very little time in appreciating the urgency of the constitution of such a body under the conditions created by the war.

I am a member of the Board and keenly interested in its success. Any observations which I may make upon it are made in a purely constructive spirit with the object of enhancing its utility to the country. In the first place then, I may be permitted to say that although the beginning of the Board, like most beginnings, may be small, its conception must be large and liberal. It must not, in its composition or working, bear the appearance of a mere *ad hoc* body created to meet the immediate exigencies of the war. The demands of the war are no doubt urgent and must have priority over other demands, but the Board should function as a body charged with the organization and promotion of industrial research throughout the country, and co-ordinate the immediate needs of the war with the long-range policy of the industrial development of the country as a whole. While concentrating on what is immediately required to meet war needs, it must also be in a position to survey the long-term industrial requirements of the country and to plan a programme of research to meet them. Perhaps after the urgent demands of the war are over, its composition can be enlarged and made more representative of the Universities, Government scientific services, the non-official scientific bodies and the industrialists of India so as to enable it to pursue its ultimate plan and policy.

No institution, however well conceived and designed, can flourish except in suitable political atmosphere and conditions. It was the unfortunate experience of the last War that industries created under the stress of the war languished and died in the post-war period for want of encouragement and protection from Government. The activities of the Board will not lead to the creation of new industries unless industrialists are assured of reasonable protection from Government in the post-war period, when foreign competition will be keen.

I have already quoted the words of Lord Rutherford as a warning against excessive Government control. The progress hitherto made by the Board is not as rapid as we would have wished in war time. This is partly due to the constitution of the Board under which executive authority is concentrated in a central department of Government and partly to the inadequate staff provided for the very urgent and important work that has to be done. There is one other aspect on which I desire to touch and that is the financial. Even for a beginning, a grant of Rupees five lakhs is inadequate and shows to my mind an inadequate conception of the magnitude of the tasks involved. Associated with the Department of Scientific and Industrial Research in Great Britain are the great National Physical Laboratory at Teddington and important Boards, such as the Fuel Research Board, the Food Investigation Board, the Forest Products and Building Research Institutes and a number of similar bodies as well as Research Associations. While we must necessarily make a very modest beginning, the development of the Alipore Test House into a National Physical and Chemical Laboratory seems to be obviously and urgently required. In a subsequent part of this address I shall dwell upon the necessities of a Fuel Research Board to investigate the very pressing problems of fuel and power, upon which the whole industrial structure of the country has to be based. All this work will require large funds but I have not the slightest doubt that the money so spent will be repaid manifold. It has been estimated that the annual expenditure on research in Great Britain in normal times before the war was roughly six million pounds, of which one-half was spent on research directed to industrial needs,

including the money spent by Government, University Departments and private firms. The figure for the U.S.A. is estimated to be 300 million dollars, while the corresponding figure of the U.S.S.R. is reported to be of the nature of 120 billion roubles. With the exception of the U.S.A. and the U.S.S.R., there is no country in the world with natural resources so vast and varied as India. With the expenditure of even a fraction of the amount spent by the countries just mentioned on industrial research, these resources can be investigated and developed so as to place India in the front rank of the industrial countries of the world.

THE STEEL INDUSTRY IN INDIA

I propose now in the second part of my address to speak to you on some developments in the steel industry in India during the last ten years; but before doing so I should like to make a few remarks on the raw materials which are commonly used in the manufacture of iron, namely, iron ore, coal and limestone, and particularly coal, which is the most important of our raw materials and of the most general interest.

Iron Ore

So far as iron ore is concerned, India is one of the richest countries in the world, being endowed by nature with very extensive deposits of very rich ore. The Singhbhum-Orissa field is the most extensive in India. The tonnage of this field has been estimated by Mr. H. C. Jones of the Geological Survey, at 3,000 millions, and, if anything, it is probably an underestimate. Practically the whole of this ore is hematite, with an iron content of sixty to sixty-nine per cent.

Coal

While the position regarding iron ore is highly satisfactory, that regarding coal, particularly the coal required for the smelting of the iron ore, is far from satisfactory. Dr. Fox has estimated the resources of Indian coal over four feet in thickness up to 2,000 feet in depth and twenty per cent. in ash at 24,000 million tons, of which coal of good quality up to 18 per cent. ash is 6,000 million tons, while coking coal suitable for metallurgical purposes is only 1,400 million tons. Coking coal in India is confined to the Gondwana coal beds of the Damodar Basin. On the existing methods of working coal the total life of the coking coals of India is estimated at about fifty years. This is a position which neither the Government nor those interested in the metallurgical industry can view with equanimity. The most recent Committee appointed by the Government of India to investigate the position and suggest remedies was the Burrows Committee of 1937. The terms of reference to that Committee were unfortunately not comprehensive enough and the legislative measures taken by Government as a result of the recommendations of the Committee are mainly confined to the ensuring of safety in Mines. The problem of Indian coking coals is, however, one of conservation as well as of safety and if proper attention is paid to conservation, the problem of safety will more or less automatically be solved. Legislation in the interest of safety which places additional burdens on the industry without assisting it to dispose of its production in a more scientific manner, is likely to worsen the situation by hastening the uneconomic exploitation of the good coals by the smaller colliery owners. What is required is the rationalization of production as well as of consumption. In order to achieve the rationalization of consumption, a thorough chemical and physical survey of the coalfields beginning with the Jheria coalfield, in conjunction with a scheme of coal utilization research is absolutely necessary.

Fuel Research Board

For that purpose it is necessary to create a Fuel Research Board as a branch of the Board of Scientific and Industrial Research with a proper personnel, adequate staff and funds. Power is a *sine qua non* of the development of all industries and the proper conservation and utilization of the coal resources of the country is the first question that requires to be tackled in any consideration of the power resources of the country. The geological survey of the various coalfields has been excellently and exhaustively carried out at great expense to Government and it is high time that a scientific, chemical and physical survey were also carried out. Such a survey has been instituted in Great Britain and has resulted in a mass of most valuable information regarding British coals which has in many instances completely altered the attitude of the industry to many varieties of coal and enabled a more efficient use to be made of them.

On the production side the most important problem is that of the co-ordinated sequence of working the coal seams. Perhaps the worst feature of the working of Indian collieries is the exploitation of the richer coal from the lower seams for immediate profit and the neglect of the upper seams resulting in subsidences, fires and destruction of valuable coals. The co-ordinated sequence of working will prevent this destruction of top seams and will eliminate to a large extent the necessity of stowing altogether. No. 16 seam in the Jheria coalfield is a case in point. This coal has good coking properties but because of its high ash content and doubtful swelling tendencies it has been comparatively unexploited, either as a steam or coking coal.

The washing of coals is another question affecting production. In many cases the ash in the Jheria coals is inherent or when present in a free condition is of about the same specific gravity as the coal itself, thus making the separation impossible or difficult, but it has been proved that in certain of our high ash seams the ash content can be reduced by liquid flotation. 11 and 16 seams Jheria come into this category and further research is necessary to determine whether it is economically feasible to wash these coals with a view to reduce their ash content.

On the consumption side, the chemical and physical survey into our coal seams in conjunction with coal utilization research will in the first place enable us to determine the range and variety of coals suitable for coking as well as boiler purposes. Research is necessary in order to ascertain whether with proper blending and mixing the demands of the metallurgical industry need be confined to the very limited Jheria field. Several experiments have been carried out in the past, but further systematic research by the Board suggested above into blending with high ash coking coals, with swelling coking coals and with non-coking coals may result in the conservation of good coals and an extension of the range of coals available for metallurgical purposes.

Similar research is also required in the case of power coals. A certain amount of information is already available but is mainly confined to the mixing of the high volatile coal in the Raneegunge field with the low volatile coal in the Jheria field for the export market and bunkering only. These low volatile coals from the Jheria are good metallurgical coals and research will doubtless produce suitable blends for export and power requirements without encroachment on these valuable low volatile coking coals.

The utilization of high ash coals for electrical generation at the sources of production and the distribution of the energy thus supplied over large areas is another problem of the first magnitude. The erection of a large power station on the coalfields for the distribution of cheap power to surrounding areas has already been advocated from many sources and has engaged the attention of the Government of Bihar. Further investigation of the suitability of the coal for such a purpose will help greatly towards the fulfilment of this very desirable project and should form one of the first objects of enquiry by the proposed Board.

Low temperature carbonization tests with various classes of coal, particularly of high ash, which are unsuitable for metallurgical purposes and also unsuitable on account of high ash content for transport to distant areas for power purposes, should provide another field for the activities of the Board. A number of scientists from the platform of this Congress as well as outside have advocated the cheap production of domestic coke on a mass scale and the utilization of the resultant tar for industrial purposes. The present very small production of soft coke is capable of very great extension if a market can be found for the coke as well as the resultant tar, even if the gases are ignored for the present. The economic difficulties in the way of such a proposal need not be minimized but practical experiments have already been carried out at Patna under the auspices of the Bihar Government and these would seem to indicate that further research may prove successful. Should this prove to be the case, there would be an adequate supply of raw material for the foundation of hydrogenation plants. This may be regarded as a distant aim as such plants have not proved too successful in other countries, but with the cheap Indian coals and the large quantities of tars which would be available from their low temperature carbonization success may be easier of attainment in India than in other countries.

The Board should also investigate the question of the scientific preparation of coal for the market and buying and selling on specification. This would mean the

complete abandonment of the existing unscientific system of grading. The seams which were originally graded, have become exhausted or are nearing exhaustion or have deteriorated to such an extent that the classification is in many cases no longer applicable. The disposal of the metalliferous production of the country has long been established on the international basis of scientific specification and it would be equitable to both buyer and seller alike to establish the buying and selling of coal and coke on a similar basis.

If my proposal for the establishment of a Fuel Research Board is approved, I would suggest that as the Jheria coalfield is practically the sole source of our coking coals and is also the centre of the Indian School of Mines, the headquarters of the Board should be situated at Dhanbad and the School of Mines and its laboratories which should be adequately equipped for the purpose, should be utilized for the investigations of the Board.

THE TATA IRON AND STEEL COMPANY: PROGRESS IN THE LAST DECADE

The last decade has seen a great expansion of the Steel Industry in India, accompanied by improvement in the various processes and the application of scientific methods of control. You will forgive me if I confine my remarks to the works of the Tata Iron and Steel Company alone, as the steel-making plant at Bhadravati in the Mysore State was put up in 1936 and has an annual capacity of about 20,000 tons only, while the plant of the Steel Corporation of Bengal with an estimated capacity of two hundred to two hundred and fifty thousand tons of finished steel, has begun operation very recently. In terms of tonnage, the progress can be measured by the fact that while the Tata Iron and Steel Company produced 422,000 tons of finished steel in 1929–30, the corresponding production in 1939–40 was 777,000 tons. Ten years ago only thirty per cent. of the demand of the country for steel was met by the indigenous industry, whereas in 1939–40 about eighty-four per cent. of the demand was so met and the day is not distant when India will be able to supply not only the whole demand of the country except in a few very specialized directions but also to spare some steel for export.

Coke Ovens

Following the sequence of the manufacturing processes of steel, I begin with the coke ovens, where the coal is converted into coke. Ten years ago we had three batteries of Wilputte Coke Ovens and two batteries of the still older Koppers Coke Ovens which together produced 720,000 tons of coke, 22,300 tons of tar and 6,600 tons of ammonium sulphate. By 1940 all except one of the Wilputte batteries were replaced by three modern batteries of Simon-Carves Coke Ovens containing 54 to 55 ovens in each battery at a cost of Rupees one crore and sixty-five lakhs. These batteries are of the twinflue 'Underjet' type capable of carbonizing 1,300 to 1,500 tons of coal each per working day. Arrangements have been provided for firing the ovens with coke oven gas or with the cheaper blast furnace cleaned gas. Firing the coke ovens with blast furnace gas releases the more valuable coke oven gas for use in steel-making furnaces in other parts of the plant. The twinflue construction assures a more uniform heating throughout the length and height of the oven with a resulting uniformity of the coke produced. As stated in the preceding part of the address, all coals do not give good coke and careful investigations have to be carried out in the blending and mixing of different varieties of coal. To this end three large slot bunkers of the capacity of 2,000 tons each have been installed. Coal wagons, as they arrive from the collieries, are taken over to the selected bunkers and unloaded. The coal is then mixed mechanically in the required proportions from the three bunkers and suitable mixed coal is conveyed by mechanical conveyors to the ovens into which it is charged.

The three principal by-products of the coke ovens are coke oven gas, ammonia which is turned into ammonium sulphate and tar. The sulphuric acid for the manufacture of the ammonium sulphate is made in a recently installed contact process plant producing fifty tons of 100% acid per day.

So far the manufacture of benzol as a by-product of the coke ovens has only been attempted on a very small scale in India. A plant is now nearing completion at Jamshedpur for the manufacture of benzol and toluole for the Government of India. When it comes into operation, it will be of great assistance in the manufacture of high

explosives for the ordnance factories. The plant is designed for extracting benzol motor spirit and toluole and is being installed by Messrs. Simon-Carves.

Blast Furnaces

The next stage in the manufacturing process is the blast furnace for the production of pig iron. Ten years ago, Jamshedpur had four blast furnaces; two of the capacity of 900 tons, one of 750 tons and one of 250 tons per day. The small blast furnace was completely rebuilt in 1936 and its capacity was increased to 550 tons. An entirely modern blast furnace was installed last year. The diameter of its hearth is 22 feet 6 inches, of the bosh 26 feet 6 inches and of the top 19 feet. Its height is 95 feet and volume 35,160 cubic feet. For the one year that this furnace has been in operation it is estimated to have produced more iron than has ever been produced elsewhere on a furnace of similar size over a similar period. The total pig iron capacity of the Jamshedpur plant is a million and a quarter tons per annum.

For every ton of iron made, a blast furnace produces roughly 100,000 cubic feet of gas. This blast furnace gas contains about 14 grains of dust per cubic foot of gas at N.T.P. This gas has considerable fuel value, but owing to its dirty condition its use in industrial plants, such as blast furnace stoves and boilers is restricted. It has been realized that considerable fuel economy can be effected if this gas is cleaned. In the last ten years the Steel Company has installed two large gas cleaning plants, each with a capacity of fourteen million cubic feet of blast furnace gas at N.T.P. per hour. Both the plants clean the gas to a purity of 0·008 grains of solids per cubic foot of gas at N.T.P. The older of these two plants is the Lodge Cottrell plant of the dry type which came into operation in 1934. The second gas cleaning plant is of the Brassert design. This plant consists of wooden-hurdle wet washers which not only cool the dirty blast furnace gas but also remove about eighty per cent. of the solids from the gas. This semi-cleaned gas is then passed through the Cottrell wet electric precipitators which precipitate the rest of the solids and deliver clean gas to specification.

Fuel Economy

The old concepts of fuel economy and energy distribution have been completely revolutionized by the modern scientific use of coke oven and blast furnace gases. Fuel economy and distribution of energy in a large plant like that of the Tata Iron and Steel Company is a highly specialized job, which is in charge of a special department of the plant, designated the Energy and Economy Department. The efforts of this department have succeeded in reducing the overall fuel rate from 3·56 tons of coal per ton of steel in 1930–31 to 2·19 tons in 1939–40. Modern practice aims at reducing the use of coal as fuel and replacing it by the more efficient by-product fuels, such as coke oven gas, blast furnace gas, coke dust, etc. The use of mixed gases in this connection requires special mention.

The cleaning of the blast furnace gas permits of its use in coke ovens and releases a corresponding amount of the richer coke oven gas for use elsewhere at the plant. Blast furnace gas has a comparatively low heating value of about 110 B.T.U. per cubic foot of gas, while coke oven gas has a value of about 470 B.T.U. per cubic foot. Modern practice tends to a greater use of coke oven gas or a mixture of coke oven and cleaned blast furnace gas in steel making and reheating furnaces, replacing to that extent coal which has been used so far in the form of producer gas. Fuel costs are thus greatly reduced. For the successful use of the gases it is necessary to have steady pressure of gas at the consuming ends. For that purpose two large dry gas holders for the storage of blast furnace and coke oven gas respectively have recently been installed. These gas holders act as reservoirs which smooth out the fluctuations of the gas caused by the furnace irregularities and thus assure continuous operation of boilers, coke ovens and other consuming centres. The blast furnace gas holder is a huge structure 283 feet high, 176 feet in diameter, capable of holding 5½ million cubic feet of gas at N.T.P. The coke oven gas holder is 192 feet high, 112 feet in diameter and holds 1½ million cubic feet of coke oven gas.

Steel-making Practice

The last ten years have also seen important developments in steel-making practice and a considerable increase in production.

Steel-making operations at Jamshedpur are carried out in two types of plants, the Open Hearth and the Duplex. The Open Hearth is the oldest part of the Jamshedpur

plant. Four out of the seven furnaces which we were working ten years ago, have been remodelled along modern lines and an eighth furnace has been built. The ingot production from this plant has been increased during the last ten years by over 100,000 tons per year, the figure for 1929–30 being 242,000 tons as compared with 345,000 tons in 1939–40. The Duplex steel-making process, as its name implies, consists of two operations, (*a*) blowing the molten pig iron in acid lined Bessemer Converters to remove the silicon and manganese and most of the carbon, and (*b*) transferring the blown metal to basic-lined Open Hearth tilting furnaces where the phosphorus is removed and the steel finished to chemical specification. Improvements to this plant during the last ten years have resulted in increase of production from 340,000 tons in 1929–30 to 670,000 tons in 1939–40. In addition to these two steel-making plants a four-ton electric furnace was installed in 1936 mainly for the manufacture of electric castings, while two five-ton electric furnaces have only recently been installed and are being utilized for the manufacture of class steel, spring steel and alloy steel. The installation of these electric furnaces has been of the greatest assistance in the making of superior quality of alloy steel required by the Defence Department.

A New Steel-Making Process

The most important advance made during the last decade, from the point of view of scientific research, is the practical development of the rapid dephosphorizing process. As this matter has never been the subject of public discussion in India so far, a few details will not be out of place here. As is well known, Indian pig iron contains about ·3 to ·4% phosphorus. This percentage of phosphorus in the iron neither lends itself to the straight basic Bessemer process nor to the straight acid Bessemer process. The phosphorus has to be removed to ·05% for most commercial specifications though as much as ·10% is admissible in certain products. The removal of this phosphorus is normally effected by the action of basic and oxidizing slags in Open Hearth furnaces. At the best of times this is a slow operation taking from one to several hours even in the quick working Open Hearth furnaces of our Duplex plant. In 1935, when our General Manager, Mr. Ghandy, and myself were on leave in Europe, our attention was drawn to certain developments in France, where a French Steel Engineer, M. Perrin, had carried out successful experiments in the rapid deoxidation of steel by violent mixing together of slag and steel so as to obtain a considerably greater area of contact between them than could ever be obtained in the conventional Open Hearth furnaces. This idea of the violent mixing of slag and steel was also considered applicable to the dephosphorizing operation. After a study of the French experiments, large-scale investigation over a long period was carried out at Jamshedpur and ultimately a practical method was evolved for operating the dephosphorizing process on a commercial scale under Indian conditions. This new process consists in blowing molten pig iron in an acid Bessemer converter to remove all the silicon and manganese and as much of the carbon as required. This blown metal is then poured from a considerable height into a synthetic molten basic oxidizing slag contained in a ladle. The metal comes into very intimate contact with the slag and the phosphorus is rapidly removed in the course of two or three minutes, instead of as many hours, in the normal open hearth process. As the steel and slag separate, the steel is finished to analysis and cast into ingots. The process is subject to exact control and steel of basic Bessemer quality can be made directly from the pig iron. Moreover, the dephosphorized metal can be further treated in an Acid Open Hearth furnace and steel of first class open hearth quality can be made. Thus for the first time in India it becomes possible to make acid steel out of Indian basic pig iron. A plant for the manufacture of steel by this process is now under construction. The successful development of this process may be regarded as the most important advance in steel making practice that the young Indian steel industry has made. It is likely to have far-reaching effects on the establishment of several new industries in India, such as locomotive manufacture and the manufacture of railway wheels, tyres and axles, for which acid steel is specified.

Rails

In the manufacture of rails, advance has been made as a result of metallurgical research during the last ten years. Investigations have shown that medium manganese rails with a lower carbon and higher manga-

nese content of 1·10 to 1·40% have superior properties of wear and resistance as compared to straight carbon rails with higher carbon and lower manganese content. There is a growing tendency to replace straight carbon rails with medium manganese rails. On the other hand, high chromium rails were found unsatisfactory.

An interesting advance has been the installation of Sandberg Ovens for the Sandberg controlled cooling process for rails. All over the world the controlled cooling of rails has come to be looked upon as a definite and desirable advance on the old practice of cooling rails on open hot-beds. The Tata Iron and Steel Company have obtained exclusive rights in India for the working of the Sandberg process. They have installed four Sandberg Ovens for the controlled cooling of their rails. Experiments are also being conducted in the welding of rails in the track. This aims at giving longer lengths in the track between joints and helps to provide a smoother ride.

Plates

In the Plate Mill, the most interesting development in the last decade is the installation of a modern normalizing furnace for plates. This furnace was first installed to normalize some of the high tensile steel plates for the new Howrah Bridge. By the aid of this furnace it is now possible to produce in India normalized plates which had formerly to be imported. The furnace is also used to normalize certain structural sections. Thus materials with a new range of physical properties have been made available to the designing engineers. It is worth noting that Indian plates have largely replaced foreign plates even for the most exacting demands, such as for barges and ships.

Sheets

Ten years ago, the Sheet Mill at Jamshedpur consisted of five hand-operated units and the total annual production was 38,000 tons. The rolling of sheets was an extremely strenuous manual operation calling for considerable physical exertion. Production was low, defects and rejections were high. To-day we have only four hand-operated mills and three mechanized units with an output of 170,000 tons. These new mechanized units have produced tonnages which, as far as can be ascertained, constitute a world record for this type of equipment. Besides the ordinary quality mild steel sheets, the Jamshedpur plant now turns out different classes of sheets with a high grade finish, including 'Tiscor' and high carbon sheets. Panel plates for coach building are supplied to the Railways and the various engineering firms. Other special developments in sheet manufacture are the rolling of drum stock for the manufacture of drums and containers, enamelling stock for deep-drawing and subsequent enamelling, furniture stock and, lastly, special sheets for steel helmets for the army.

Low-alloy Steels

It is owing to applied research that most of the significant advances in the steel industry at Jamshedpur during the last decade have been made possible. I have already mentioned the case of the rapid dephosphorizing steel. The development of low-alloy steels is another very important instance. Engineers in general and transportation engineers in particular are beginning to realise that ordinary carbon steel performs its functions only at the expense of unnecessary dead weight and excessive loss due to its low resistance to corrosion and abrasion. The problem of providing suitable materials for lighter weight is not one relating to mechanical strength alone. It requires the integration of several properties in one material, such as strength, resistance to impact, corrosion and abrasion, ease of forming, satisfactory welding, etc., as well as moderate cost. With this end in view, metallurgical research was conducted at Jamshedpur, resulting in the development and commercial manufacture of a low alloy, high-tensile steel containing copper and chromium known as 'Tiscrom'. This steel is being employed in the construction of the new Howrah Bridge.

The introduction to India of another low-alloy high-tensile steel, sold in America under the trade name 'Corten' deserves mention. Research conducted in America had shown that the addition of a high percentage of silicon and phosphorus to alloy steel, containing chromium and copper, resulted in a low-alloy high-tensile steel of the same properties as those of Tiscrom but with the additional important property that it could be readily welded by all methods of rapid welding such as oxy-acetylene and automatic electric welding. After an investigation into the possibilities of the manufacture

of this steel in India and an examination of the claims put forward for it, the Tata Iron and Steel Company obtained exclusive rights for the manufacture and marketing of this steel in India under the trade name of 'Tiscor'.

Special Steels

Reference has already been made to the installation of the electric furnaces. Among the special qualities of iron and steel manufactured from these furnaces are chrome-manganese steel for crane track wheels, thirteen per cent. manganese steel for crusher jaws and similar hard wearing parts of machinery, nickel-chrome heat-resisting steel and cast iron for various castings required to withstand high temperatures and nickel-chrome-molybdenum steel for crane pinions, mill rolls, etc. The manufacture at Jamshedpur of special alloy steel rolls has enabled the Steel Company to replace similar rolls of foreign manufacture.

Since the outbreak of the war, intensive research work has been undertaken for Government in connection with the manufacture of armoured vehicles in India, and as a result a bullet-proof armour plate of special alloy steel which has stood the firing tests and has been accepted by Government, has been developed. Suitable steels for the manufacture of armour piercing shot and for steel helmets have also been produced. Research work was undertaken at the instance of Government in regard to the supply of steel suitable for telegraph wires. This steel has now been successfully manufactured and the wire rolled at the works of the Indian Steel and Wire Products out of this material has met with the approval of the Department of Posts and Telegraphs.

Researches are being carried out on behalf of the Defence Department in connection with the welding of chrome molybdenum steel plates for aircraft manufacture and in other directions.

Most of the high speed steel requirements of the plant for machine tools are now being met by the remelting of tool scrap in the high frequency induction furnace in our laboratories. High chrome and stainless steels have been produced in the furnace in small quantities.

Besides metallurgical research, fuel research, chemical research and research in refractories are being pursued. Researches of the fuel department in blending and mixing have resulted in the determination of the most suitable varieties of coals for coking and similar purposes. Research on refractories has enabled us to evolve a better class of refractories for the use of the steel plant. Indian raw magnesite was at one time considered unsuitable for use in basic steel furnaces. Investigations carried out at Jamshedpur have now made it possible to produce in India the Steel Company's entire requirements of finished magnesite. Metal-cased magnesite bricks made at Jamshedpur have given very encouraging results for the superstructure of basic furnaces. Chrome magnesite brick for use above the slag line in basic Open Hearth furnaces in place of silica brick is another important development in the refractory field. Other interesting developments in brick manufacture are investigations into the possibilities of the manufacture of foresterite, semisilica, mica-schist and mullite bricks. An entirely new process has been developed for the manufacture of mullite refractories using cyanite, silimanite and alusite, India having practically a monopoly of the first two. Very productive work has also been accomplished with regard to high-temperature mortars. Superior types of mortars for high temperature work are now being locally made, replacing many of the imported brands.

A Nucleus for a National Metallurgical Laboratory

To facilitate research work, a modern well-equipped laboratory was erected in 1937 at a cost of over rupees ten lakhs. May I express the hope that with the facilities for metallurgical research provided by this laboratory and its workers, Jamshedpur may in the near future become the centre of a National Metallurgical Laboratory and Research Institute and thus be enabled to play a greater and worthier part in the development of the metallurgical industry in India.

When the titanic conflict now being waged ends, as end it must, in the triumph of the democracies and the cause of human freedom, I pray that India may emerge from it with the foundations of its industrial as well as political freedom well and truly laid, so that she may be properly equipped to play her rightful part in peace and in war as a worthy member of this great commonwealth of nations.

LIBRARIES AND LIBRARY MOVEMENT

BY

S. R. RANGANATHAN

(*University Library, Madras*)

ON the 5th of November 1940, the Public Library at Bangalore celebrated the Silver Jubilee of its installation and the event may be used as an occasion for reviewing the library movement in India.

The sister State of Baroda had already made a name in library matters when the Bangalore Public Library was established. For as early as 1907 the late Gaekwad had instituted public libraries in the State. In 1910 he secured the services of Mr. W. A. Borden, an American librarian, to work out a library system for his State. Mr. J. S. Kudelkar was the first Indian librarian to take charge of this library system. In collaboration with Mr. M. N. Amin he developed the Central Library, the numerous local libraries and the travelling library system.

The example of Baroda did not take long to stimulate Mysore. In 1914 two public libraries of the modern type were established, one in Mysore and the other in Bangalore. These libraries were formally opened to the public in 1915. They were managed directly by the Government till 1921 when they were transferred to the care of mixed committees of officials and non-officials.

The first British Indian province to think of a library system was the Punjab. In 1915 its university engaged the services of Mr. A. D. Dickinson, an American librarian again, to reorganise its library on modern lines. Fortunately for the Punjab he went beyond his scheduled work, organised a library training class, wrote the *Punjab library primer* and initiated the library movement in the province. Thus again 1915 turns out to be an important date in the library history of India.

Taking our stand on that year let us have a look backwards and forwards. Isolated libraries had existed all along from very early days. But they do not constitute library movement. The apex of such isolated libraries in the provinces was constituted at Calcutta with the name Imperial Library by the Curzon Act I of 1902.

On the non-official side the Andhradesa has done pioneering work. The first Andhra library is said to be the one started about the year 1898 in the village of Kumudavalli in the West-Godavari district by Ganjam Venkataratnamgaru. The library workers of Andhradesa had also been actively sponsoring an All-India Library Conference during the twenties, as one of the many auxiliary conferences associated with the Indian National Congress.

Work through non-official library associations has now become a regular feature. The Madras Library Association was founded on the 30th January 1928 and the Punjab Library Association on the 30th January 1929. The Andhradesa Library Association and the Bengal Library Association had come into existence a few years earlier. An All-India Library Association was formed in 1933 and is holding biennial conferences. Since that date provincial library associations have been formed in some other areas like the United Provinces (1935), and Bihar (1939).

The Andhradesa library workers have the credit of having started the first library periodical. It was called the *Indian library*

journal. It sent out a few issues at irregular intervals and it seems to have now gone into suspended animation.

The Punjab Library Association inaugurated the *Modern librarian* in November 1930. It began first with the ambition of being a monthly. After the first two issues it was put to the necessity of issuing double numbers in alternative months. Now it has avowedly declared itself a quarterly. It has completed ten volumes of considerable value.

The Bengal Library Association has been issuing a *Bulletin* at regular intervals. The combined numbers 1 and 2 of volume 2 which came out in 1938 appear to be the latest ones.

The Andhradesa Library Association started a bilingual quarterly entitled *Andhra granthalayam* early in 1939. It has just now completed the first volume by clubbing issues 3 and 4 into a double number.

The Madras Library Association has inaugurated an annual periodical with the title *Memoirs of the Madras Library Association.* The first volume came out in April last.

Of all the different Library Associations of the country it is the Madras Library Association that is most prolific in its publications. It has inaugurated three important series of publications: Everything About Something Series; Bibliographical Series and Publication Series.

The first is an attempt to bring out books on current thought in modern Tamil, as such books are not easily forthcoming in the book-market of the province. Two books have come out in this series till now.

Sixteen items made up of book-selection lists in South Indian languages, library companions to certain text-books and bibliographies in certain subjects have appeared in the bibliographical series.

The volumes of the publication series form the most considerable contribution of that Association to the world's library literature. Nine volumes have come out so far. Three more are in preparation. The intention is to cover all branches of Library Science. The basic book is the *Five laws of library science* (1931) which in the words of Sir P. S. Sivaswami Iyer "reduces everything connected with the libraries to five cardinal principles from which all the rules of library organisation and management are developed as necessary implications and inevitable corollaries". The other volumes cover the fields of classification cataloguing, administration, reference service and bibliography. Another publication of some value on reference service was published this year by Mr. Fazl Elahi. Library movement cannot flourish in our land unless substantial treatises come out continuously from all parts of India.

The Madras Library Association has also the credit of having made two outstanding contributions which have received international recognition. They relate to classification and cataloguing.

The Colon Classification sponsored by that Association has many novel features of which its composite nature is the outstanding one. The *Library Association record* (London) estimates it with the words "The result is almost perfect. ... A new subject creates its own number in the notation". The *Year's work in librarianship* pronounces it to be the best exercise in synthetic classification. On account of its composite nature and the eight devices it has developed, it carries the individualisation of ideas and subjects to a far greater degree than any other scheme.

The Association has also sponsored what is perhaps the only complete code in book

form in the English language for the preparation of a classified catalogue. The *Library Association record* (London) estimates the *Code* as one of considerable value.

The credit of having started the first school of librarianship in India goes to the Punjab University Library. It was inaugurated in 1915 and is still being continued as a six months' course every alternate year.

The second school of librarianship was founded by the Madras Library Association in 1929 as an annual summer school for three months. This was taken over by the University of Madras in 1931. In 1938 the course was converted into a full-timed one year one leading to the University diploma. About 130 persons have been so far trained by the Madras school.

The third school of librarianship was begun by the Andhra University in 1934 on a rather ambitious scale out of all proportion to what was warranted by the library conditions of the country. It had to be suspended from 1937.

Another school of librarianship is being conducted in alternate years by the Imperial Library at Calcutta.

The Bengal Library Association is also giving occasional short courses.

The outstanding library buildings of the modern type that were completed during the last few years are those of the Central Library at Baroda and the University Libraries of Lahore, Benares, Madras, Waltair, Annamalainagar and Lucknow. In most of these libraries the buildings are designed to suit the open access system. Most of them are also provided with artificial lights so as to make it possible for the libraries to work during nights. The longest hours are kept by the Madras University Library which works on all the days of the year without exception, for 13 hours from 7 A.M. to 8 P.M.

The above resume of the recent history of Library Movement in India significantly omits mention of any considerable State action, in particular, of library legislation, which forms the basis of continued library development in other countries of the world. The first attempt at promoting library legislation was made at the Library Service Section of the First All-Asia Educational Conference held at Benares in 1930. A Model Library Act with compulsory clauses was presented to that Conference. This Model Act was made the core of the *Five laws of library science.*

Munindra Deb Rai Mahasai had the Model Act adapted to the conditions of Bengal and sought to introduce it in the Bengal Legislative Council. But it was disallowed by the Viceroy. The Madras Library Association promoted a public library bill on the lines of the Model Act but converting all the compulsory clauses into optional ones to avoid opposition from government. The Viceroy's consent was received and the support of most of the district boards and municipalities who were to be created library authorities was also obtained. The bill was introduced into the Legislative Council by Mr. Basheer Ahmed Sayeed in October 1933. It came out of the Select Committee stage in 1934, but all further progress was blocked by the unfriendly attitude of the then Finance Member. Though it was not formally withdrawn the bill lost its life by the dissolution of the Legislative Council in 1936. On the reconstitution of the legislature under the Government of India Act, 1935, Mr. Basheer Ahmed Sayeed gave notice in October 1937 to introduce the bill in the Madras

Legislative Assembly. But it was not permitted by His Excellency the Governor.

It is a matter of experience all the world over that Library Movement cannot take root and thrive, if it is made to depend purely on private philanthropy or the enthusiasm of private individuals. Nor will it receive the necessary attention of the local bodies simply because libraries are mentioned in a schedule of the Local Boards Acts among the various purposes on which a local body may spend any money that it may occasionally spare. Local bodies will go the whole hog in the matter only if there is a separate public library act implemented by a department of public libraries presided over by a professional librarian.

The experience of several countries points to the need for even a more drastic step with compulsory clauses in the public library acts which empower penalties being imposed upon local bodies which do not exercise their library function with sufficient vigilance and to a prescribed standard.

Library legislation will be required if the country is to be filled with a co-ordinated network of live public libraries capable of functioning as efficient instruments of universal education. That, as we have seen, we are yet to have in India. But so far as the needs of the intellectual aristocracy go, it can be said that India is well provided by its university libraries and the libraries of the various departments of the Government of India and of the several Research Institutions. Before the last world depression, money was easily forthcoming and many libraries were well provided for. It was this fact that brought their resources to an adequate level. But of late the finances of most of the libraries are being crippled. If a more generous and far-sighted policy is not inaugurated it will not be long before even the combined resources of all such libraries prove inadequate to the requirements of the nation-building research activities.

Will it be too much to hope that the Government and universities will strive their very best to continue their library policy along liberal lines? Will it be too much to hope that they will realise that money spent on libraries is not money thrown away for ever, but on the other hand every pie spent on increasing the resources of the libraries and on improving their man-power and their service to the public will come back to the community in the form of extended literacy and efficient citizenship.

It is true that the war in which the country now finds itself entangled and the political abnormality that prevails in the land make the present moment inopportune to speak of library reforms, library legislation and above all finance for libraries. But surely the war is not going to be a perpetual feature of the world. Similarly the present political impasse is not going to be permanent. It is not asking for too much if we appeal to those who now wield the power that the libraries should not be starved at least for the obvious economic reason that the gaps now created will cost far more than now to get filled up later. Countries which are in the thick of the fight have not developed any serious indifference to the library needs of their people. Again thanks to the activities of library associations a good deal of popular enthusiasm has been created for libraries. If the enthusiasm is made to die out by a stingy policy, it would be far more difficult to whip up enthusiasm a second time.

THE RUMANIAN EARTHQUAKE OF NOVEMBER 10, 1940

BY

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(Colaba Observatory, Bombay)

A VERY severe earthquake shook Bucharest and parts of Rumania at 7-09 a.m. Indian Standard Time (3-39 a.m. Rumanian Standard Time) on Sunday, the 10th November 1940. In Bucharest, according to Reuter's reports, the earthquake lasted for five minutes causing great damage. Almost all the buildings in the city were damaged, the Carlton building, an eight-floored sky-scraper, crashed and many people were caught in the debris and perished; hundreds of domes, chimneys and towers came down like ninepins and not a single ceiling was left intact. There were also explosions of oil tanks causing many fires. In the provinces, Galatz is reported to have suffered the highest death roll and the greatest damage; in Foscani the centre of the city was completely destroyed and in Ploesti many buildings crashed; in Campina, Baicoui, Bustenari, Buzeau, Rumical and Sarat in the oil regions, there were explosions of oil tanks and breaking of pipe lines and considerable destruction of property and many casualties. In Bulgaria, the shock was reported to have caused some victims.

The earthquake was felt very severely in Kiev in Ukraine, Sinope and Inebolu in Turkey on the shores of the Black Sea and less severely in Budapest, the Hungarian capital. A shock was also reported to have been felt in the Marseilles region. Reports about the amount of damage and consequent loss of life are so far vague, evidently due to the present unsettled conditions in Europe. However, it is believed that the number of dead may not be less than 1,000.

The maximum intensity of the earthquake as obtained from the available macroseismic data is about VIII in the modified Mercalli scale (VIII–IX in the Rossi-Forel scale), and the area over which this intensity was observed is found to be over 10,000 square miles. The extent of the area over which the earthquake was severely felt is as large as 500,000 to 600,000 square miles. The great extent of the area in which the shock was severely felt with relation to the observed maximum seismic intensity suggests an abnormal depth of focus.

Rumania lies a little to the north of the Alps-Caucasus-Himalaya seismic belt. Earthquakes in this (Rumanian) region have not been as frequent as in Italy, Greece and Bulgaria which lie well inside the belt referred to above. In Milne's[1] *Catalogue of Destructive Earthquakes*, only 14 shocks were listed in Rumania in the whole of the nineteenth century beginning with the disastrous one of 1802. In the last twenty-five years, no destructive earthquake appears to have occurred though about ten shocks were recorded having their epicentres in Rumania. Of late, this region appears to have become seismically active. Three shocks were reported to have been felt in Rumania on February 1, 1940, the epicentre of which, according to Bucharest seismologists, lay in the Black Sea, 500 miles east of the Rumanian capital. These were not recorded by the Bombay seismographs. Another shock, which was, according to *Nature*,[2] one of the greatest during that month occurred on February 29, 1940. The epicentre was near Lat. 45° North and Long. 27° East in Rumania, according to Zurich seismologists. This was recorded by the seismographs in India as a shock of moderate intensity, but the tentative epicentre as determined at Bombay on the basis of Indian seismograms and published data of a few European and African stations was Lat. 34° North and Long. 25° East, near the island of Crete.[3] This differs much from the Zurich determination. In this connection, it may be noted that the only damage reported was from Afium Karahisar in Anatolia. This indicates that the epicentre given by Bombay is nearer the affected area. On October 22, 1940, a slight shock was recorded by the Indian seismographs and the epicentre was near Bucharest where according to Reuter's report three shocks were felt bringing down house-fronts and ceilings.

The destructive earthquake of November 10, 1940, was recorded by all the seismographs in India, and the epicentre as tentatively determined at Bombay, immediately on receipt of telegraphic reports from Agra and

Calcutta was near Lat. 44°·5 North and Long. 27°·0 East about 60 miles away from Bucharest. The first movements as recorded by the Bombay seismographs give an azimuth of about 30 degrees West of North while the tentative epicentre lies about 38 degrees West of North. The tentative epicentre agrees well with the centre of the area of destruction which is near Lat. 45° North and Long. 27° East. The depth of focus of the shock was found to be about 150 km. from the Bombay seismograms and this is supported by the Hyderabad records, which were kindly loaned by the Director of the Nizamiah Observatory, Hyderabad, Deccan. The Calcutta seismograms and the data which were received just at the time of going to press also give about 145 km. The same order of depth was obtained from the macroseismic data using the well-known relationship[4a] between the observed maximum seismic intensity and the area over which the shock was felt.

The Bombay seismogram of the Rumanian earthquake as recorded by the Milne-Shaw East-West component is reproduced in Fig. 1. The great number of clear phases, which is a regular feature of deep focus seismograms, is to be noted. The maximum movement is recorded after sScS. The very well developed long-period waves commence with great amplitude and are followed by poor 'maximum' waves.

In their study of Depth and Geographical Distribution of Deep-focus Earthquakes all over the world, B. Gutenberg and C. F. Richter[5a,b] have listed only two deep shocks with their epicentres in Rumania as shown below:—

Date	Epicentre	Depth of focus
1929, Nov. 1 .	45°·9 N., 26°·5 E.	160 km.
1938, July 13 ..	45°·7 N., 26°·7 E.	150 km.

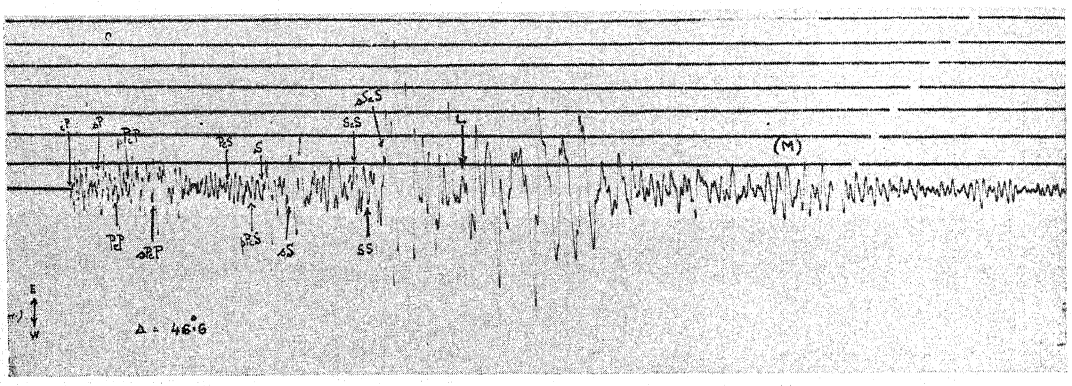

FIG. 1

Though most of the deep focus shocks are confined to the Pacific, a few isolated regions are found in Europe and Asia where intermediate* shocks are known to occur. In Europe, there are two such regions, *viz.*, Rumania and the Aegian Sea. According to B. Gutenberg and C. F. Richter,[4b] "the isolated intermediate shocks in these regions are all related with active or comparatively late vulcanism".

* Earthquakes are classified by modern seismologists into normal, intermediate and deep ones. Normal shocks are those which have their origin comparatively near the surface, the intermediate ones originate at depths varying from 30 km. to 250 km. and the deep ones are from 250 km. to 700 km. from the surface.

[1] J. Milne, *Report of the British Association for the Advancement of Science*, 1911, p. 649–740.

[2] *Nature*, 1940, **145**, 460.

[3] *Seismological Bulletin, India Meteorological Department Jan.-March*, 1940, p. 10.

[4a] B. Gutenberg and C. F. Richter, *Bull. Geol. Society of America*, **49**, 269.

[4b] — —, *Ibid.*, p. 281.

[5a] — —, *Ibid.*, p. 267.

[5b] — —, *Ibid.*, **50**, p. 1519.

THE INDIAN ACADEMY OF SCIENCES

THE sixth Annual Meeting of the Indian Academy of Sciences was held at the Andhra University, Waltair, on Friday, the 27th December 1940 and the three following days. The session was inaugurated by the Maharajah Sahib of Jeypore at 6 p.m. on the 27th at the Convocation Pavilion of the University in the presence of a large and distinguished gathering of Fellows of the Academy, Delegates from various Universities and Research Institutes, members of the Reception Committee and the elite of Waltair. Welcoming the Fellows and the Delegates, Dr. C. R. Reddy, the Chairman of the Reception Committee, traced the growth of modernism in scientific education in India and stressed the importance of scientific research for the successful prosecution of modern warfare. He aptly remarked that "the front line of defence has shifted from the battlefield to the Nations' research laboratories and manufacturing centres" and "any amount of money invested by a wise Government in strengthening the research institutions and developing new industries under the control of men who possess a sound knowledge of the fundamental sciences will, far from being a waste, go a long way to make the country safe and strong". Sir C. V. Raman, the President of the Academy, then delivered his Presidential address on "Crystals and Photons", a detailed summary of which appears elsewhere in this issue.

The Scientific meetings of the session were held on 28th, 29th and 30th instants. Forty-four papers in Section A, Mathematical and Physical Sciences, and fourteen papers in Section B, Biological Sciences, were communicated for the meeting. About twenty papers were read by the authors present and were followed by lively discussion. The rest were taken for read.

Symposium.—A symposium on the "Natural Resources of the Andhra Area and Allied Topics" was held under the auspices of the Academy on the 29th instant. Thirteen papers bearing on the various aspects of the subject were presented. They fall under four groups, (1) Fauna and Flora, (2) Mineralogical and Geological, (3) Electrical and (4) Chemical. A brief summary of the proceedings is given below.

In an interesting paper on the "Faunal Resources of the Andhra Area", Dr. H. Srinivasa Rao gave a rough outline of the fauna of the Andhra country from a knowledge of its physical environment and of the geographical distribution of animals in the Oriental Region (a faunistic division of the world in whch the Andhra area is included). The richness of the tract both in animal and bird life, the abundance and variety of marine and freshwater fish in the seas along its long coast and in the lakes and rivers and the wide distribution of the several Indian species of invertebrates which could be expected in this area, were brought out by Dr. Rao together with the important role animal life plays in the economy of Nature. Two other papers in the series contained discussions of the "Paleontology of the Rajahmundry area", (1) the "Fossil Fauna" by Mr. S. R. Narayana Rao, and (2) "The Fossil Flora" by Mr. K. Sripada Rao. A detailed review of the "Flora and the Plant Resources of the Andhra Area" was given by Mr. J. Venkateswarlu.

Three papers were presented on the "Mineralogical and Geological" resources of the Andhra country. Dr. C. S. Pichamuthu gave a survey of the geological antiquities of the rocks found in many districts and the mineralogical deposits found in the Andhra areas lying on the borders of the Mysore State. In his paper on "Metalliferous Minerals" Dr. M. S. Krishnan dealt with the occurrence of metallic ores in several districts in the Province. Dr. C. Mahadevan communicated a paper on the "Minerals of the Andhra Desa" in which he suggested that a careful geological survey and prospecting for minerals in this area would yield fruitful results. The vast possibilities for the development of the ceramic industries were stressed by Dr. G. Gopala Rao. The raw materials such as red burning clay, fireclays and deposits of graphite which occur in the Andhra area in abundance form the basic materials for the manufacture of structural ceramics, refractories, crucibles, etc. Dr. Rao also gave an account of a survey of raw materials for fine ceramics carried out by him and displayed some articles made by him in the Andhra University.

On the Electrical side, Mr. A. R. N. Rao read a paper on the "Resources and Development of Power in Northern Circars" and indicated the rapid progress being made in

the generation and distribution of electric power by means of charts and figures. He also made some valuable suggestions for the economic use of power in industries, and for the planned development of a network of industries in the country. Mr. D. Seethapathi Rao dealt with the possibility of hydroelectric power development in the Andhra Northern Circars. Mr. S. S. Moorthy Rao in his instructive paper on the "Wireless Engineering Developments applicable in the Andhra area" indicated the urgent necessity for the installation of a wireless communication and a wireless Broadcasting Station in the Andhra Province. Illustrating by means of lantern slides what has been achieved in the Posts and Telegraphs Department of the Government of India, he further indicated the vast possibilities of manufacturing wireless component parts with the raw materials available in the Andhra area.

Dr. T. R. Seshadri gave a detailed account of the "Resources for Organic Chemical Industries" under three main headings: (1) agricultural, (2) forest products and (3) marine products. He also presented the results of the investigations carried out by his co-workers and himself in the Andhra University in the various branches of Chemical industry, such as (1) vegetable drugs and insecticides, (2) fruits, (3) wood distillation and power alcohol, (4) dyes and tans, (5) paper, (6) oils and soaps and (7) gums, resins and wax. Mr. C. Venkata Rao also read a paper on the "Paint and Varnish Materials of Andhra Desa".

In view of the importance of the subject-matter dealt with in the symposium and the many valuable and constructive suggestions put forward by the authors, it is proposed to publish the Proceedings shortly.

Public Lectures.— Three general addresses were given during the session. On 28th December Sir C. V. Raman delivered an illustrated lecture on "Structural Colours". On 29th December, Dr. Herre, Professor of Zoology, Stanford University, gave a very fascinating talk on "Fishes and Fisheries". On 30th December, Dr. K. S. Krishnan, F.R.S., discoursed on "Magnetic and Other Properties of Graphite Crystals".

Socials and Excursions.—During the session the Fellows and Delegates were entertained at Tea by the Reception Committee, the Pro-Chancellor and the Research Students' Association. An enjoyable excursion to the Vizag Harbour was also included in the programme.

BOARD OF SCIENTIFIC AND INDUSTRIAL RESEARCH

AN important decision taken at the meeting of the Board of Scientific and Industrial Research, held at Calcutta on 9–10 January 1941, relates to the constitution of an **Industrial Research Utilisation Committee**, to be composed mainly of industrialists. The Commerce Member to the Government of India will be the Chairman of the Committee which is "to advise the Government regarding the best means of utilising the result of researches, which have proved commercially possible. It will also advise the Government regarding the terms on which the results of these investigations, the patent rights of which are vested in the Government, could be handed over either to existing industrial concerns or to new concerns which might have to be created".

The Hon'ble Sir A. Ramaswami Mudaliar, who presided over the meeting, in his opening speech congratulated, on behalf of the Board, the recipients of Honours in the new year who included Lala Sri Ram and Dr. Bhatnagar (both knighted) and Mr. Pillay, the Secretary of the Board, who had been awarded O.B.E. He remarked that it was exactly nine months since the Board had been constituted and that some of the results of the researches and investigation were now beginning to come in. The Director of Industrial Development and some of the members of the staff had achieved results of practical interest to industrialists and the stage had been reached when their exploitation had to be considered. He announced that the Government had decided to constitute an *Industrial Research Utilisation Committee* to assess the commercial worthiness of these researches and encourage their industrial exploitation.

LETTERS TO THE EDITOR

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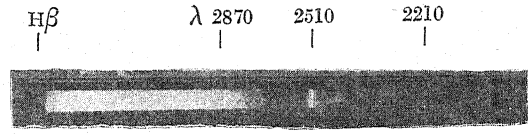
EXCITATION OF LIGHT EMISSION FROM QUARTZ UNDER IMPACT WITH CANAL-RAYS OF HYDROGEN AND NITROGEN

EXCITATION has been observed with canal-rays of nitrogen and hydrogen of different energies lying between 4–12 kV., with time of exposure of 2 hours each. The discharge tube used is 3·5 cm. in diameter, with a canal of moulded aluminium 0·7 cm. in length and 0·2 cm. in diameter. The quartz window is fixed to the observation chamber of the discharge tube, at a distance of 5·0 cm. from the canal in such a manner as to make an angle of about 45° with the axis of the tube. Direct light from the canal-ray beam was eliminated by suitable precautions. For lower voltages, the intensity of the light given out by the bombarded portion of the window is very feeble. Visually the light given out appears to be predominantly rose-red in colour (in the case of canal-rays of hydrogen) with a tinge of greenish-blue. In the case of bombardment with canal-rays of nitrogen the greenish-blue colour is more prominent.

In the case of excitation by canal-rays of hydrogen, in addition to the atomic and molecular spectra of hydrogen, three groups of lines lying approximately at λ 2870, 2150, 2210 are observed. The lines belong either to silicon or oxygen (or both). OI and SiI have nearly identical spectra in this region. The resolving instrument used is not qualified to allow a definite conclusion as to the emitter. The same lines are also obtained when the excitation is brought about by canal-rays of nitrogen.

Much more interesting is the remarkable change obtained in the intensity distribution of the hydrogen continuum, observed when the canal-rays of hydrogen are used for the excitation. Figs. 1 and 2 give the relative intensity distributions in the continuum here obtained and that observed with canal-rays of hydrogen when care is taken to eliminate the fluorescent light from the quartz window. The relative intensity distribution curve in the former case, shows two distinct maxima in the regions λ 4000 and λ 3200 with a shallow minimum in between the two, at about λ 3600. The maximum at λ 4000 can perhaps be seen with low intensity but the one at λ 3200 or the minimum at λ 3600 are certainly absent in Fig. 2. The fact that, with excitation by canal-rays of nitrogen, only the above three characteristic groups of lines are obtained, without the presence of the continuum shows that quartz



Excitation of quartz by H_2 canal-rays of 8 kV.

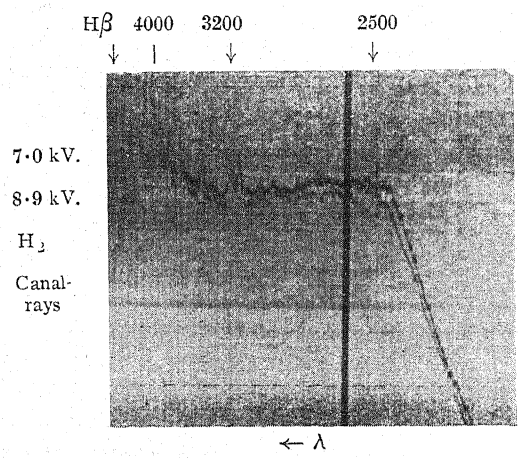


FIG. 2

The pure hydrogen canal-ray spectrum

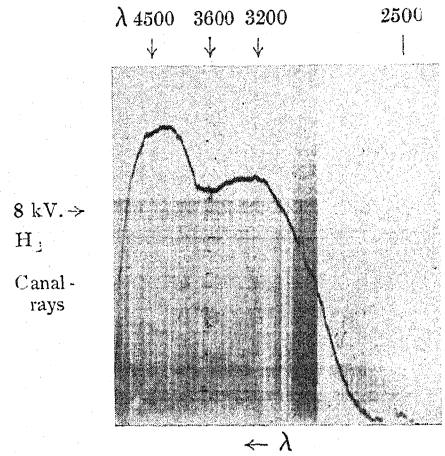


FIG. 1

Excitation of quartz by canal-rays of hydrogen

itself does not emit a continuum, and the continuum observed must therefore be ascribed to hydrogen itself. This conclusion finds some support in the observation of Goldstein[1] that the colour of the fluorescence produced under impact with canal-rays depends on the chemical nature of the canal-rays themselves.

The peculiar change observed in the intensity distribution must therefore be ascribed, either to an overlapping of the usual continuum by some other spectrum characteristic of hydrogen, excited under conditions here obtaining, or to an effect of the type described by Smith[3] brought about by the presence of foreign gases. It may be interesting to note here, that Wien[2] had found a minimum in the intensity distribution of the continuous spectrum emitted by canal-rays of hydrogen at about λ 4000. It is still obscure under what conditions this minimum obtains, for it has been observed only in one other case, by Herzberg,[4] in the case of an electrodeless discharge in hydrogen. The minimum observed in the experiments here described, lies at λ 3600, which is sensibly different from the value given by Wien. There is a continuous spectrum observed by Herzberg and Brasefield[5] extending from roughly H_β to H_γ with a maximum of intensity in between, obtained at extremely low pressures (~ 0·0005 mm. Hg.). The presence of this spectrum, at the pressures here used (0·01 mm. Hg.) appears somewhat unlikely and secondly an overlapping of the usual molecular spectrum by the Herzberg-Brasefield continuum will not explain the observed intensity distribution. As for the other possibility, *viz.*, the effect of the presence of oxygen and silicon, on the intensity distribution of the continuous spectrum of hydrogen, there are unfortunately no available data on the subject.

The positions of the maxima and the minimum, in the intensity distribution here observed, do not show any appreciable dependence on the energy of the exciting canal-rays (for the range of energies here used). The relative values of the maxima, on the other hand, vary sensibly with the energy.

I take this opportunity to offer my grateful thanks to Prof. Dr. Asundi for his kind interest in the investigation, and to Dr. Nawazish Ali,

Muslim University, Aligarh, for kindly taking the microphotographs.

V. T. CHIPLONKAR.

Physics Department,
Benares Hindu University,
November 8, 1940.

[1] W. Wien, 'Kenalstrahlen', *Handbuch der Experimental Physik*, 1927, Band **14**, 443.

[2] *Ibid.*, p. 693.

[3] N. D. Smith, *Phys. Rev.*, 1936, **49**, 345.

[4] G. Herzberg, *Ann. d. Physik.*, 1927, **84**, 553.

[5] W. Finkelnburg, 'Kontinuierliche Spektren' *Struktur und Eigenschaften der Materie*, Band **20**, Julius Springer, 1938, p. 184.

GRAVIMETRIC DETERMINATION OF MANGANESE WITH 8-HYDROXY-QUINOLINE

BERG[1] showed that manganese could be precipitated quantitatively by means of 8-hydroxyquinoline ("Oxine") as a dull yellow crystalline compound with the composition $Mn(C_9H_6ON)_2, 2H_2O$. The precipitation was carried out either from (1) a neutral or weakly acid solution containing sodium acetate and a small amount of sulphite or hydroxylamine by adding an excess of an alcoholic solution of the reagent, or (2) from a mineral acid solution containing an excess of an acetic acid solution of the reagent by adding dilute ammonia until weakly alkaline. The precipitates obtained by both methods, however, could not be satisfactorily dried to constant weight since at 110° C. drying was very slow and above this temperature appreciable decomposition occurred. The gravimetric determination was, therefore, carried out by Berg (*loc. cit.*) by igniting the precipitate to the oxide, Mn_3O_4 with oxalic acid and weighing.

Raikow and Tischkow[2] showed that the composition of the ignited tetroxide depends on the temperature and the nature of the atmosphere surrounding the precipitate during the ignition. Further the procedure adopted by Berg for the gravimetric determination suffers from the fact that no advantage is taken of the precipitation of manganese as the heavier oxyquinolate molecule.

During the present investigation it was found that the heat stability of the precipitates during drying depended considerably on the method of precipitation. While precipitates obtained by Berg's first method were easily decomposed at temperatures higher than 110° C., those obtained by the second method were quite stable at temperatures as high as 150–170° C. Prolonged drying (20 hours) at 150° C. did not produce any decomposition in a large number of cases studied with amounts of manganese varying from 0·3 to 60 mg. In a few cases, however, a slight superficial discolouration of the precipitates was observed but this was inappreciable even when dealing with the smaller amounts of manganese. It was also found that even this discolouration did not occur if the precipitation was carried out in the presence of a little sulphurous acid. Drying at even a higher temperature (170° C.) showed that the precipitates were quite stable and the discolouration inappreciable. A temperature of 150° C. was, however, considered to be the most suitable for drying. Constant weight of the precipitates was attained in two to three hours at this temperature and the composition of the dried precipitates corresponded to $Mn(C_9H_6ON)_2$ containing 16·03 per cent. manganese.

The influence of large amounts of ammonium chloride, sodium chloride and ammonium oxalate, as occur in the filtrate from "lime and strontia" in rock analysis, on the precipitation of manganese was also studied with a view to adapt the "oxine" method for the precipitation of magnesium and residual manganese in rock analysis. It was found that both manganese and magnesium could be precipitated together quantitatively adopting Berg's second method provided ammonium salts, and oxalic acid which interfered with the precipitation of magnesium as the oxyquinolate, were removed by the nitric acid method.[3,4] The precipitates thus obtained were dried to constant weight at 150° C. and weighed. To determine the manganese in these precipitates, the weighed

precipitate was dissolved in nitric acid (1:1), the solution evaporated to dryness in a platinum dish and the organic matter ignited. The residue was dissolved in concentrated nitric acid and the manganese determined colorimetrically by the periodate method. Satisfactory results were obtained for both manganese and magnesium.

The above work was done by the author in collaboration with H. F. Harwood and L. S. Theobald of the Imperial College of Science and Technology, London. Details will be published later.

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Department of Chemistry,
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Waltair,
December 17, 1940.

[1] Berg, *Z. anal. Chem.*, 1929, **76**, 191.
[2] Raikow and Tischkow, *Chem. Ztg.*, 1911, **35**, 1013.
[3] Hillebrand and Lundell, *Applied Inorganic Analysis*, 1929, p. 119.
[4] Miller and McLennan, *J. Chem. Soc.*, 1940, 656.

ON THE VELOCITY OF SOUND IN AND CHEMICAL REACTIVITY OF BROMINE AND IODINE

THE velocity of sound in metallic elements has been found to be dependent upon the atomic frequency and the least distance separating the atoms.[1] This least distance between the atoms concerned determines the chemical reactivity and approximates to "critical atomic approach value" for any type of action.[2] The direct formation of bromides and iodides suggest for the 'critical atomic approach' values which may be taken to be equal to the least distance separating the atoms of these two elements. With these values of least atomic distances and author's values of atomic frequencies, attempt may here be made to compute the velocities of sound in these non-metallic elements by applying the author's formula for the case of metals.

Element	Atomic Frequency	Distance of closest approach of atoms	Valency	Constant	S. calc.	S. obs.
Bromine	$2\cdot76^{(4)}$	$1\cdot88^{(5)}$	1	10	131·1	135·0
Iodine	$2\cdot1^{(4)}$	$2\cdot12^{(5)}$	1	10	113·1	107·7

It would be evident from the above table that the values so obtained are comparable with those observed.[3] It would thus appear that the author's formula for the calculation of velocities of sound in metallic elements may be extended to such calculation at least in two non-metals. Further, there would appear to be a relationship between the velocity of sound in bromine and iodine and the 'critical atomic approach values' for the direct formation of bromides and iodides. So velocity of sound appears to be significant for bromide and iodide formation.

The formula proposed for the calculation of velocity of sound in metallic elements may be represented thus

$$S = L\left\{\left(\frac{1}{2\pi}\sqrt{K}\sqrt{\frac{P-V}{V}\cdot\frac{Ze^2}{r^3}\cdot\frac{N}{M}}\right)\times\left(f_2\times f_1(V)\frac{P}{V_i\times d^{k_1}}\right)\right\}$$

where S is the velocity of sound in metallic elements, L a constant having value 2·54; $\left(\frac{1}{2\pi}\sqrt{K}\sqrt{\frac{P-V}{V}\cdot\frac{Ze^2}{r^3}\cdot\frac{N}{M}}\right)$ the atomic frequency[4] and $\left(f_2\times f_1(V)\frac{P}{V_i\times d^{k_1}}\right)$ the distance of the closest approach of atoms.[5]

In the factors $\left(\frac{1}{2\pi}\sqrt{K}\sqrt{\frac{P-V}{V}\cdot\frac{Ze^2}{r^3}\cdot\frac{N}{M}}\right)$ and $\left[f_2\times f_1(V)\frac{P}{V_i\times d^{k_1}}\right]$, P represents parachor, V the atomic volume, Z the valency, M atomic weight, e the elementary charge, N Avogadro's number, V the ionisation potential, K and $\sqrt{K}$ constants having the values 0·925 and $0\cdot415\times10^{12}$, and $f_2\times f_1(V)$ a constant depending upon valency having the dimension $\frac{M^{1/2}}{L^{\cdot575}\times T}$ which in the present instances takes the value ·615.[5]

In the application of the above formula to obtain the velocities of sound in the two non-metals cited the value of the constant L is to be multiplied by 10.

BINAYENDRA NATH SEN.

Chemistry Department,
Burdwan Raj College,
Burdwan,
October 9, 1940.

[1] Sen, B. N., *Gazzetta*, 1938, **10,** (68), 662.
[2] —, *Proc. National Academy of Science, India*, 1937, **8,** 1, 6.
[3] *International Critical Tables*, **6,** 465.
[4] Sen, B. N., *Journ. Ind. Chem. Soc.*, 1934, **11,** (4), 243.
[5] —, *Gazzetta*, 1938, **10,** (68), 656.

THE MILK CLOTTING ENZYME OF *WITHANIA COAGULANS*

THE fruit of *Withania coagulans* contains an active rennet which can be obtained in highly concentrated form by the following procedure: The partially dried fruits are ground up with water, the extract filtered through paper pulp and the clear solution treated with ammonium sulphate. The precipitate formed at 25 per cent. saturation is discarded as it contains very little activity. The material that separates on further addition of ammonium sulphate to 65 per cent. saturation contains the whole of the enzyme. The precipitate is separated by centrifuging, redissolved in water, and the solution after being dialysed free from ammonium sulphate, is filtered through paper pulp. Ten volumes of acetone are now added, the precipitate is centrifuged, washed with small quantities of acetone and dried in the desiccator. 100 g. fruit pulp usually yield about 3 g. of enzyme. The material thus obtained is a brownish white powder which has a milk coagulating action nearly 30 times that of the original *fruit pulp*, 0·125 g. of powder being capable of bringing about the coagulation of 1 litre of fresh milk at 30° in 30 minutes. The preparation is quite stable and retains its activity unimpaired on keeping at room temperature for weeks.

For determination of activity comparison was made with a standard pepsin solution prepared according to Rona[1] (1931) the substrate being either freshly boiled milk (Michaelis and Rothstein)[2] or milk powder (Rona and Gabbe).[3] The optimum temperature for the action of enzyme is 48°. Three minutes at 90° completely destroys it, the destruction being 40 per cent. at 70° and 75 per cent. at 80°. The main properties of the enzyme from *Withania coagulans* as compared to those of other well-known milk clotting enzymes are given in the following table.

	Enzyme from *Withania coagulans*	Papain	Pepsin
ACTIVITY (Quantity of enzyme for clotting 1 lit. of milk in 30 min.) ..	125 mg.	31 mg.	3·2 mg.
Optimum Temperature	48°	87°	37°
Proteolytic action .	—	+	+

It will be seen that the preparation from *Withania coagulans* is only about ¼ as active as papain and 1/40 as active as pepsin. In practical cheese making however it is doubtful if papain can be utilised as a substitute for gastric rennet on account of the bitter flavour it imparts to the clot even in minute concentration. The texture of the clot formed is dependent on the time taken which is in turn determined by the quantity of enzyme and the temperature. A firm compact clot is obtained when at the optimum temperature of 48° sufficient enzyme is added to give a clot in about 20 minutes.

A finding of considerable theoretical importance is the observation that the *Withania coagulans* enzyme has no proteolytic action, no increase in amino nitrogen being observed when it is allowed to act for a week on gelatin solution at various pH's. On account of the difficulty of separating gastric rennet from pepsin the individuality of the former has often been questioned. Further in discussions on the mechanism of clot formation a proteolytic fission

of the casein molecule prior to coagulation has frequently been postulated (*cf.* Oppenheimer).[4] In the enzyme now obtained from *Withania coagulans* we have for the first time a preparation which is entirely devoid of proteolytic activity and which therefore provides clear proof of the independence of the process of coagulation to hydrolytic cleavage of casein.

The author's thanks are due to Mr. Zal R. Kothavalla, Imperial Dairy Expert, Bangalore, who suggested the research and supplied the material and to Prof. M. Damodaran for his interest in the work.

(Miss) K. M. Yeshoda.

University Biochemical Laboratory,
Madras,
December 23, 1940.

[1] Rona, *Praktikum der physiologischen chemie*, 1931, **1**, 276.
[2] Michaelis and Rothstein, *Biochem. Zeit.*, 1920, **105**, 60.
[3] Rona and Gabbe, *Ibid.*, 1922, **134**, 39.
[4] Oppenheimer, *Die Fermente*, 1926, **1**, 978.

CATALYSIS BY ASCORBIC ACID

During the course of our work on the role of ascorbic acid in physiological processes and the cause of its stability in plant and animal tissues we have found that it catalyses the reduction of silver chloride by sodium sulphite.

The experiments were conducted in brown bottles and silver chloride was formed *in situ* by adding to each bottle 10 ml. of 0·1N silver nitrate and 10 ml. of 0·1N potassium chloride solution. The requisite volumes of sodium sulphite solution and ascorbic acid solution were then added, followed by enough distilled water to make up the total volume to 50 ml. After three to three and half hours, the contents of each bottle were poured through a filter (Whatman No. 42, for fine precipitates). The residue on the filter was carefully washed until free from the soluble salts. The funnel with the filter is then put over a 250 ml. volumetric flask and the residue on the filter treated with 1 : 1 dilute analytical nitric acid. The corresponding brown bottle was also treated similarly and the liquid poured on the filter. The treatment is repeated three times to ensure complete solution of any metallic silver formed by reduction. It is well known that silver chloride does not dissolve in 1 : 1 nitric acid. The filtrate in the 250 ml. flask was made up to the mark, and the amount of silver in an aliquot portion estimated volumetrically by titration with standard potassium thiocyanate solution, using ferric alum as the indicator.

Under these experimental conditions we have found that sodium sulphite does not reduce silver chloride, while ascorbic acid does so readily. Further we made the interesting observation that in the presence of sodium sulphite a given amount of ascorbic acid produces a much larger reduction of the silver halide than when it is alone.

Table I

5 Milligrammes of ascorbic acid

Volume of sodium sulphite solution 0·025 Molar	Amount of AgCl in milligrammes Ag	Milligrammes Ag obtained by reduction in 3½ hours
0	107·9	2·88
5 ml.	107·9	6·26
10 ml.	107·9	9·04
15 ml.	107·9	9·71

The results indicate that ascorbic acid induces the reduction of silver chloride by sodium sulphite. The following table shows the influence of the concentration of the inductor, namely ascorbic acid on the rate of reduction, keeping the concentration of sodium sulphite at a constant but fairly high value.

Table II

Concentration of sodium sulphite 0·05 Molar

Amount of ascorbic acid	Amount of AgCl in milligrammes Ag	Milligrammes Ag obtained by reduction in 3 hours
5 milligrammes	107·9	7·08
10 ,,	107·9	12·18
15 ,,	107·9	17·00

It will be seen from the above results that the rate of the induced oxidation increases with increasing concentration of the inductor.

The mechanism of this induced oxidation may be as follows:—

$$AH_2 + 2\,AgCl \rightarrow 2Ag + 2\,HCl + A$$

Ascorbic acid

$$A + Na_2SO_3 + H_2O \rightarrow AH_2 + Na_2SO_4$$

Dehydroascorbic acid

This is similar to the mechanism suggested by Pandalai and Gopala Rao[1] for the reaction between silver chloride and sodium sulphite induced by hydroquinone or metol.

In order to obtain confirmation of this mechanism we prepared dehydro-ascorbic acid by oxidation of the vitamin in aqueous solution with Norit Charcoal and found that the oxidized form thus prepared is incapable of reducing silver chloride by itself, while it can do so in the presence of sodium sulphite.

It will be of interest in this connection that Hopkins and Morgan,[2] Borsook and Jeffries[3] found that glutathione reduces dehydro-ascorbic acid to ascorbic acid.

$$2G\text{-}SH + A \rightarrow AH_2 + G\text{-}S\text{-}S\text{-}G$$

Glutathione

It is by this mechanism that Hopkins and Morgan explained the protection of vitamin C from oxidation in tissues.

G. Gopala Rao.
T. V. Subba Rao.

Andhra University,
Waltair,
November 15, 1940.

[1] *Zeit. Anorg. Chemie*, 1933, **215**, 23.
[2] *Biochem. J.*, 1936, **30**, 1446.
[3] Borsook and Jeffries, *Science*, 1936, **83**, 397.

STRAINS OF *COLLETOTRICHUM FALCATUM* WENT

Colletotrichum falcatum Went is widely known as the causal organism of red rot of sugarcane, a disease present wherever sugarcane is grown. While surveying the red rot flora in the cane-growing tracts of America, Abbott[1] came across differences in the cultural characters of the parasite. He could distinguish two principal races among his collection which for convenience he designated as light and dark races. He found also that these two types varied in their virulence.

Red rot broke out in an epidemic form in North Bihar during 1939–40 season and did considerable damage to the crop. Specimens of diseased canes were obtained from several localities and cultures taken from affected tissues adopting a standard method of culturing in all cases. Differences in the morphology of the cultures obtained could be noticed in one month when two distinct types and an intermediate form could be distinguished. The following are the descriptions:

Type A.—The colony of this type is cottony and floccose in texture, white in colour during the first two weeks assuming a very light tint of gray with age. Slimy pink masses of conidia are absent in this culture.

Type B.—The texture of the colony is loose and silky. For the first two weeks the aerial mycelium is almost translucent and on account of this character it is difficult to define the actual shade of gray to which it belongs even with the help of Ridgway.[2] Abundant dark pseudopycnidial masses are to be seen in the aerial mycelium while an enormous number of slimy masses of conidia are produced on the surface of the medium; the slimy masses are of salmon colour (Ridgway, *loc. cit.*). Old cultures exhibit a more compact texture with the loose silky mycelium more or less disappearing with age. On oatmeal agar this grows much faster than Type A.

Type C.—The colony of this type has a compact velvetty texture and is darker than Type A. Conidia are produced in pink masses sparingly with a tendency to confine themselves to the margins of the media. This is perhaps an intermediate form of A and B.

In certain cases during the tissue-culture examination two types of the parasite were met with and no antagonism was observed between the races. This is in agreement with the findings of Abbott.[1]

In the absence of actual specimens of Abbott's light and dark races the three types met with in Bihar red rot flora cannot be designated in terms of Abbott's descriptions but Types A and C seem to answer closely to the light and dark races respectively except that the former does not appear to produce abundant pink masses of conidia. The culture sent by Dr. Mundkur to America for comparison belonged to the dark race according to Abbott.[1]

A preliminary test was conducted to see whether the morphologic differences noticed could be correlated with physiologic differences also. The rates of spread of the two races in 3-eye setts of four varieties, Co 213, 299, 421 and B. 04 were taken as a basis. The setts were inoculated in the middle internode with 8 days' old cultures of Types A and B and kept at room temperature (30–32° C.) for a fortnight. The length of spread was measured and it was found that the linear spread was equal on both sides of the point of inoculation. The organism spread along the entire width in all cases and hence this feature was not taken into account for measuring the index of virulence.

The index was arrived at by dividing the length of the sett by the length of the spread of the organism. The average spread is tabulated below.

TABLE I

Variety	Index of Virulence	
	Type A	Type B
Co 213	3·71	1·96
Co 299	1·49	2·52
Co 421	2·08	2·95
B. 0·4	1·37	4·35

The two races appear to vary as regards their rate of spread within the sett and the variety of the host also influences the rate of spread. This index of virulence, however, is not an indication of the varietal susceptibility which should also take into account the entry of the parasite.

The relation between the specialisation exhibited by *Colletotrichum falcatum* Went and the epidemic outbreak of red rot in North Bihar is under investigation.

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Mycology Section,
Sugarcane Research Station,
Pusa, Bihar,
August 18, 1940.

[1] Abbott. E. V., *Tech. Bul.*, 641, *U. S. Dept. Agri.*, 1938.

[2] Ridgway, R., *Colour Standards and Colour Nomenclature*, Washington, 1912.

PRODUCTION OF FRUIT-BODIES OF *AGARICEUS POLYPORUS* BERK. IN ARTIFICIAL CULTURE

Polyporus agariceus Berk. is a saprophyte, usually growing on prostrate logs or dead branches. Bose[1] reported it from Barkuda Islands, Orissa with *P. arcularius* (Batsch) Fries and *Favolus ciliaris* Mont. given as synonyms. The species has been collected from Darjeeling (Hooker f.), Mussoorie (Gollan), Ceylon and several other parts of the world. Though of rare occurrence, it has also been collected on several occasions from Behala, Ballygunj and Shyambazar in the suburbs of Calcutta (Bose, Banerjee).

While making an extensive cultural study of some of the wood-rotting fungi common in Bengal, a fresh sporophore of *Polyporus agariceus* was collected in October, 1940, from Shyambazar, Calcutta, growing saprophytically on logs of *Shorea robusta* (sal). Spore-deposits were taken immediately on sterile agar plates from which several polyporus cultures were made in potato-dextrose agar and kept under different conditions of light and temperature. In all cases germination of spores started within 24 hours.

On the 10th day of inoculation the whole surface of the slant was covered with a felty growth which condensed irregularly making

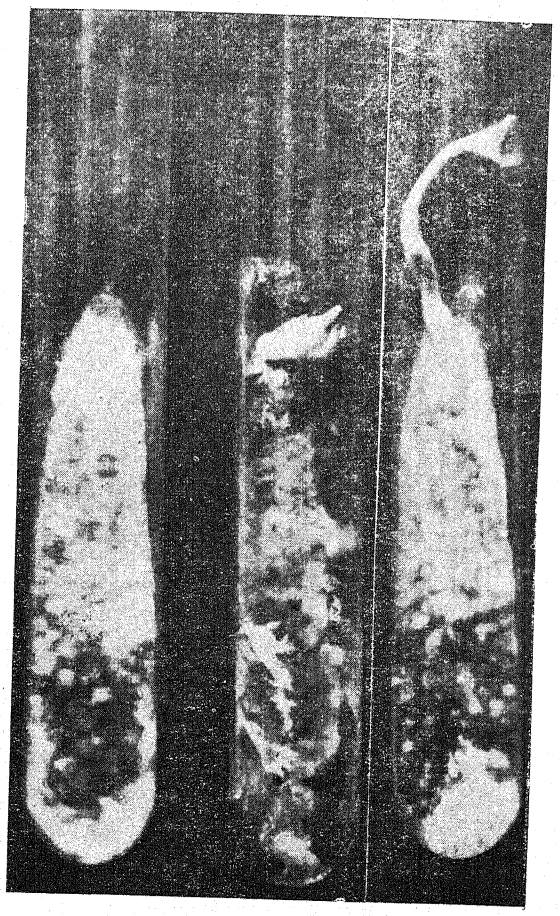

FIG. 1. Cultures showing gradual development of the fruit-body of *P. agariceus* Bark. (Nat. size)

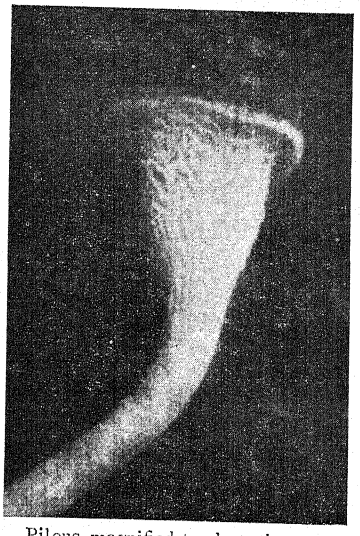

FIG. 2. Pileus magnified to show the pore-mouths

the surface of the slant uneven. The condensed portion became light cinnamon drab to cinnamon drab in colour (Ridgways's Color Standards and Color Nomenclature). The first culture took 23 days to fructify at room temperature and in diffused light, but in subsequent subcultures under the same conditions the period was reduced to one week only. A total period of 4 to 10 days was required for the complete development of the fructifications. It first appears as a small protuberance which goes on growing in length for about 3 to 9 days and terminates in a distinct flattened knob which ultimately expands to form a typical, small, yellowish-brown, umbilicate pileus during the next 24 hours. The margin of the fully expanded pileus is densely clothed with very minute hairs. Pore-mouths, though small, are distinctly hexagonal and slightly projected. Sections of pore-tube show well-developed hymenium with clavate basidia (about 12 to $17\mu \times 3$ to 4μ) each with 4 long sterigmata terminated by white, oval spores (about 6 to $8\mu \times 2$ to 3μ).

Similar fructifications were also obtained on the same medium when sub-cultures were kept in a cold room (22° C.) in diffused light within 14 days after inoculation.

In all cases it was observed that the stalk of the sporophore was negatively geotropic during its growth but became positively phototropic after the formation of the flattened knob. The phototropic curvature of the stipe takes place a little below the pileus. In complete darkness the fungus fructifies but the rate of elongation as well as the length of the stipe is greatly increased and the size of the pileus is slightly reduced.

Detailed cultural studies are now in progress, the results of which will be communicated elsewhere.

The work has been conducted under the guidance of Mr. S. N. Banerjee and is still being continued. My sincerest thanks are due to him for this. I also take this opportunity in expressing my indebtedness to Prof. S. P. Agharkar for his kindness in affording me

facilities in various ways during the progress of this investigation.

MADHUSUDAN CHAKRABARTY.

Botanical Laboratory,
Calcutta University,
December 4, 1940.

[1] Bose, S. R., *Polyporaceae of Bengal*, **9** ; *Jr. Dept. Sc. C. U.*, **9**, p. 36.

CHROMOSOMES OF *RICCIA HIMALAYENSIS* St. (Ms.)

STUDY of the differentiation of sex in plants and animals has always fascinated biologists to look for deeper causes underlying this great morphological fact; and, one of the most widely accepted explanations of this phenomenon is the sex-chromosome mechanism. Towards the beginning of the present century the sex-chromosome was discovered in animals, particularly in the Insecta, by workers like McClung[1] (1902), Wilson[2] (1904) and others; but not till 1917 was it found in plants, when Allen[3] (1917) first discovered it in a Bryophyte, *Sphœrocarpus donnellii*. Subsequent researches showed that it occurs in plants belonging to other groups also, *e.g.*, in *Rumex, Humulus, Cannabis*, etc. Many bryophytic genera were also investigated with a hope of finding it in them, and it was found in some of them too, *e.g.*, in *Pallavicinia;* but with the growing mass of information about the cytology of liverworts, it became evident that a heteromorphic chromosome as one finds in *Sphœrocarpus* is not of universal occurrence in them. For example Showalter[4] (1921) did not find it at all in *Conocephalus*; whereas the reports regarding its occurrence in species of *Riccia* like *R. Curtisii*[5] or *R. Bischoffi* were conflicting.

A careful consideration of the various Indian liverworts described by the late Prof. Kashyap[6] (1915, 1916, 1929, 1932) does suggest a possibility of finding a sex-chromosome in some of them at least; but unfortunately our knowledge of the cytology of these forms, except perhaps that of the Codoniaceæ worked out by Mehra[7] (1938), is very meagre. Even the commonest genera like *Riccia* or *Marchantia* have not been worked out thoroughly. An investigation, therefore, of some of the species of *Riccia* found in this part of the country was undertaken and the results obtained in one of them, namely, *Riccia himalayensis*,[8] are given below.

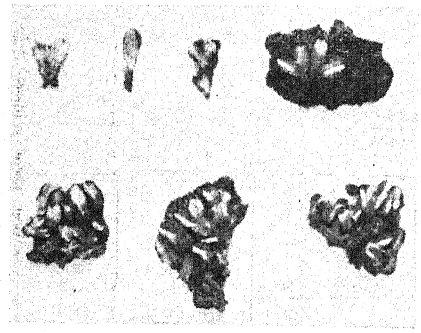

FIG. 1

Riccia himalayensis St. (Ms.). ⅔ Natural size.

The material for the present investigation was collected in the vicinity of Ahmedabad and Poona and fixed in Allen-Bouin, Flemming's strong fluid, Navaschin's and other fixatives. It was cut by the usual paraffin or Dioxane method and stained with Heidenhain's Hæmatoxylin. Many clear equatorial plates were obtained in the cells of young developing antheridia and some in the meristematic cells on the dorsal surface near the growing point of the thallus, but not in the cells undergoing sporogenesis. This is largely due to the fact that the spore-mother-cells undergoing tetrad divisions are full of oil globules and granular cytoplasm which render the achromatic spindle obscure; and this has been the experience of many other workers also.[9]

Fig. 1 is a photograph of the plants the chromosomes of which have been determined and are shown in Fig. 2. Fig. 2 *a* and *b* show them in antherids and Fig. 2 *c* shows them in a meristematic cell of the thallus cut slightly obliquely. It is evident that there are eight chromosomes in the haploid nucleus of the species. Seven of them are slender, elongated, not straight, but bent in crooked forms and

consequently irregular in outline. The eighth element is much smaller than the rest and is often elusive on account of its small size and

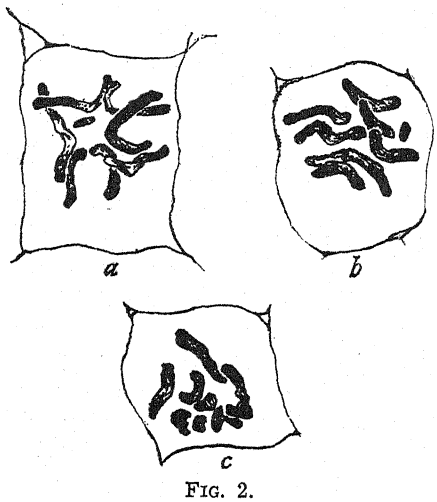

FIG. 2.

Riccia himalayensis St. (Ms.). Chromosomes: (*a*) and (*b*) Polar views of equatorial plates in antherids ; (*c*) in a meristematic cell of the thallus. × 1200.

dot-like form. This is perhaps the reason why authors like Beer[10] (1906) have said that the reduced number of chromosomes in *Riccia glauca* is either seven or eight. In our preparations also we did get plates showing only seven chromosomes but in other clear metaphase plates the occurrence of the eighth element was unmistakable. The attachment of the seven large chromosomes is atelomitic and that of the small eighth element telomitic. There is no heterochromosome in this species; and the diploid number of chromosomes seems to be 16. It is interesting to note that this very number is found in two other species studied by Lorbeer[11] (1934) and Siler[12] (1934), namely in *Riccia fluitans* and *Riccia donnellii*, whereas [the great majority of the species like *Riccia crystallina, Riccia sorocarpa, Riccia arvensis* have only 8 chromosomes in the diploid condition.] Evidently *Riccia himalayensis* is a diploid species as contrasted with species like *Riccia crystallina* which have the basic eight number. This is perfectly in accordance with Heitz's[13] (1927) observation that 'the liverworts with 8 or 9 chromosomes are predominantly dioecious, whereas those with 16 or 18 or other multiples of the basic number are predominantly hermaphroditic'.

Both the authors express their great appreciation of the helpful guidance they received from Prof. J. J. Asana, M.A. (Cantab.), in course of this investigation and wish to express their sense of gratitude to him.

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December 14, 1940.

[1] McClung, C. E., *Biol. Bull.*, 1902, **3,** 43.
[2] Wilson, E. B., *Science*, 1905, **20,** 564.
[3] Allen, C. E., *Ibid.*, 1917, **46,** 466.
[4] Showalter, A. M., *Bot. Gaz.*, 1921, **72,** 245-49.
[5] McAllister, F., *Bull. Torrey, Bot. Club.*, 1928, **55.**
[6] Kashyap, S. R., *New Phytol.*, 1914, **13,** 206, 226 ; *Ibid.*, 1915, **14,** 1 and 308 ; *Journ. Bom. Nat. Hist. Soc.*, 1917, **24,** 343 ; "Liverworts of the Western Himalayas and the Punjab Plain," Part I, 1929 and Part II in collaboration with R. S. Chopra, 1932.
[7] Mehra, P. N., *Proc. Ind. Acad. Sci.*, 1938, **8,** 1.
[8] This species is perhaps synonymous with *Riccia discolor* L. et L. (*Vide* Kashyap, *New Phytol.*, 1915, **14,** 18 ; see also *Journ. Bom. Nat. Hist. Soc.*, 1917, **24,** 349. A somewhat similar opinion about this species has been expressed by Dr. S. K. Pande of the University of Lucknow, in a letter to the senior author (T. S. M.) dated 29th October 1940.
[9] See Campbell, D. H., *Mosses and Ferns* (3rd Ed.), 1918, p. 34 ; see also Pande, S. K., *Journ. Ind. Bot. Soc.*, 1933, **12,** 117.
[10] Beer, R., *Ann. Bot.*, 1906, **20,** 288.
[11] Lorbeer, G., *Jahrb. wiss. Bot.*, 1934, **80,** 565.
[12] Siler, M. B., *Proc. Nat. Acad. Sci.*, 1934, **20,** 603.
[13] Heitz, E., *Abhandl. Naturwiss. ver. Hamburg*, 1927, **21,** 48.

SOIL ALGÆ OF LAHORE

FOR sometime past effort has been made to study the Algal flora of some of the representative soils from Lahore with particular attention to record, if possible, some of the new forms not already reported to be occurring in the soil. Accordingly three types of surface soils, namely,

garden, field and grass soils were taken and portions of these dissolved in Detmer and Bristol culture solutions. The flasks were put in the green house and after about a fortnight onwards different forms of Algæ which appeared were studied and recorded. The material was fixed in 4 per cent. formalin in test tubes for future work. Permanent slides were made in pure glycerine.

Myxophyceæ: A number of species of Oscillatoria and Lynbgya have been described. One species of Oscillatoria seems to be new.

Chlorophyceæ: The interesting forms recorded here are a species of Pandorina and Phacotus. Both these two genera have not been reported before from the soil as far as it has been possible to ascertain from the literature.

Euglenaceæ: Here a new form from the soil, namely, Trachelomonas has been recorded.

Altogether three new genera, namely, Pandorina, Phacotus and Trachelomonas have been recorded from the soil and which have not been reported before. Full details of this work will appear in due course and intensive study of soil Algæ is in progress.

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Department of Botany,
Government College,
Lahore,
December 5, 1940.

Waksmann, S, A., *Principles of Soil Microbiology* 1932.

West and Fritsch, *British Freshwater Algæ*.

Bristol, B. M., *Ann. Bot.*, 1920, **34** ; *New Phytologist*, 1919-20, 18 & 19.

A NOTE ON THE DEVELOPMENT OF THE FEMALE GAMETOPHYTE IN *ABROMA AUGUSTA* L. AND *PENTAPETES PHOENICEA* L.

Abroma augusta and *Pentapetes phœnicea* are both members of the family Sterculiaceæ. The former is commonly cultivated for its medicinal importance while the latter grows as weed in Bengal during the monsoon.

Literature on the embryology of the family Sterculiaceæ is meagre. Sharma[1] has referred to the relevant literature on the subject and recorded his observations on gametogenesis in three species in an earlier issue of this *Journal*.

The present investigation shows that the archesporial cell is hypodermal in origin in both the plants studied. It cuts off a parietal cell and then functions as the megaspore mother cell. The megaspore mother cell is pushed considerably inwards within the nucellus due to the division of the overlying cells. Two megaspore mother cells lying side by side have been observed in *Abroma augusta*. The reduction division is normal and a linear tetrad of megaspores is produced in both the plants, but in *Abroma augusta* some "T-shaped" tetrads have also been observed. The chalazal megaspore becomes functional in every instance. The usual course of development follows and a normal eight-nucleate embryo-sac is produced. In *Abroma augusta*, however, two binucleate embryo-sacs have been observed to lie side by side. It appears that this has resulted from the activity of the second megaspore mother cell. The mature embryo-sac shows the normal organization but the antipodals are ephemeral. The ovules have two integuments and the nucellus is completely enclosed by these.

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Calcutta University,
January 2, 1941.

[1] Sharma, Y. M. L., *Curr. Sci.*, 1938, **7**, 284.

PHYSIOLOGY OF POLLINATION IN ORCHIDACEAE

IN Orchidaceæ, the stimulus of pollination is necessary not only for the continued development of the ovary but also for the initiation of the ovules in several species. Normally pollination shortens the life of the blossom and brings about changes in the colour of the perianth. The gynostegium enlarges and the ovary is stimulated to grow into a fruit. These

are some of the changes seen in the flowers as the result of the stimulus of pollination.

In the absence of pollination the life of the blossom continues longer, the perianth remains fresh and there is no growth of the gynostegium and the ovary is arrested in its growth to form a fruit. After a period the flowers may wither away or remain on the plant ultimately drying up.

Fitting[1] observed the growth response of the gynostegium and of the ovary of several orchids on the application of dead pollinia to their stigma. Laibach,[2] Morita[3] and others experimented on the growth responses of the ovary, to the application of dead pollinia, foreign pollen and pollen extracts to the stigma. The results were sometimes positive and sometimes negative. As the result of a series of investigations by them, the existence of growth promoting substances such as auxins, hormones, etc., were shown to be present in the pollen, pollen extracts, pollen tubes, in the wall of the ovary and also in the placental tissue of orchids. Fitting further believed that the substance extracted contained no nitrogen and that it was not an enzyme.

Gustafson[4] has induced parthenocarpy in several plants belonging to diverse groups of flowering plants, by the application of pollen extracts and other growth promoting chemicals. During the past few years a number of organic compounds which stimulate the growth of plants have been isolated. But no satisfactory explanation of the mode of action of many of these growth-promoting substances in the plant body is to be found in the literature.

Laibach[2] has investigated the nature of the substance obtained from the pollinia of orchid flowers and has found that it not only caused swelling in the gynostegium of orchids but also caused a stretching of the coleoptile of oats. So Laibach is of opinion that the hormone from the pollinia and the growth substance such as auxins are either identical or closely related.

The investigations of Boysen Jensen[5] clearly show that auxins promote growth by influencing the turgor of the cells there by bringing about stretching of the cell wall. Later new material will be incorporated in the stretched cell wall, thus bringing about permanent increase in size and hence growth.

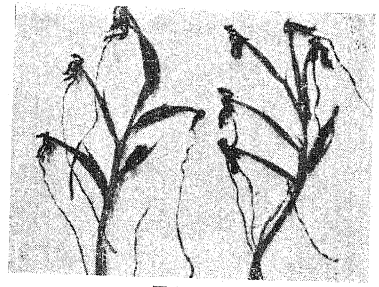

FIG. 1

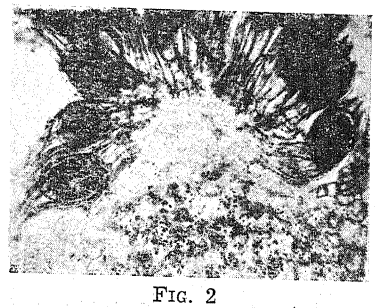

FIG. 2

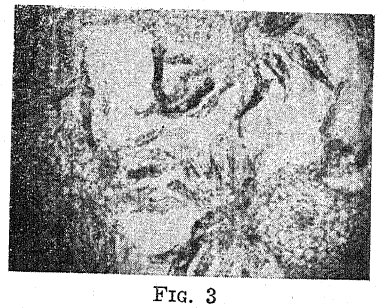

FIG. 3

Flowering shoot of *Habenaria longicalcarata* showing the pollinated and the unpollinated flowers. Both are 40 days old from the time of the opening of the flowers. The pollinated ones have developed into fruits. ¼ Nat. size.

Transverse Section of part of the ovary of the pollinated flower showing the starch grains, strained with iodine in the placental tissue and the well-developed ovules with the embryos. 40 days old. × 80.

Armstrong and Armstrong[6] are of opinion that the main effect produced by hormones when they gain entry into the living cell is the stimulation of enzymic activity which influences the metabolism in plants and animals.

The results obtained by the work of the author appear to be highly suggestive and throw more light on this problem of stimulation in the physiology of pollination in Orchidaceæ and the mechanism by which the pollen hormone promotes growth of the orchid ovary. A brief note about it is given here with particular reference to *Habenaria longicalcarata* (Rich.). Two other species of *Habenaria* and one of *Ipsea* have been studied and the results confirm the observations made on *Habenaria longicalcarata.*

When pollinated the ovary of *Habenaria* grows into a fruit and becomes much bigger than the ovary of the flower which is not pollinated. Superficially much difference cannot be made out between the pollinated and the unpollinated ovaries except in their size (photograph 1). The ovary of the unpollinated flower though forty days old and of the same age as the ovary of the pollinated shown in the above photograph, remains rich green in colour but it is inhibited in its further growth.

Histological details show that in the pollinated ovary (micro-photograph 2) there is an abundance of starch in the inner wall cells of the ovary and particularly it is rich in the placental tissue where there are a large number of leucoplasts in which starch is elaborated from the simpler carbohydrates derived from the chloroplasts. In the outer wall cells chloroplasts can be made out and the stomata in the epidermis are very efficient. The ovules show normal development since they are well supplied with the plastic nutritive material synthesized in the wall of the ovary.

In the unpollinated ovary (photo-micrograph 3) absence of starch is conspicuous and naturally associated with it are the undeveloped ovules. The chloroplasts, the leucoplasts and the stomata though apparently normal looking are not functional. They seem to remain inhibited from their normal activity.

These facts clearly indicate the mode of action of the growth-promoting substance or pollen hormone present in the pollinia of *Habenaria.* This hormone stimulates the plastids to synthetic activity by its enzymic action as a result of which plastic substances in the form of carbohydrates are synthesized in the wall of the ovary thus providing special nutrition not only for the continued growth of the ovary but also for the normal differentiation and development of the ovules.

Laibach is of opinion that the pollen hormone from the pollinia of orchid, which he investigated, and the other growth-promoting substances like auxins are either identical or closely related. How far this view holds good in the case of *Habenaria* is under investigation.

The author is indebted to Dr. M. A. Sampathkumaran, M.A., PH.D., Professor of Botany, for many a help given during the course of this work.

K. N. SESHAGIRIAH.

Department of Botany,
Central College,
Bangalore,
October 20, 1940.

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SPEARFISH ATTACKS AN OTTER BOARD

VARIOUS instances of attacks of swordfish and spearfishes on vessels have been recorded in a comprehensive paper by Gudger on "Alleged Pugnacity of Swordfish and Spearfishes".[1]

In this paper there is no record of any attack off Colombo. During minesweeping exercises of "M. S. Goliath" under the command of one of us (M.M.) off Colombo in August 1940 one of the otter boards (teak plank of 2" thickness) was pierced through by a *Makaira indicus* which left behind its sword attached to the board. The accompanying photographs (Figs. 1 and 2) by Lieut. Engineer A. Smith (Fig. 3

by S. M. Mohamed) show the various aspects of the sword and the otter board.

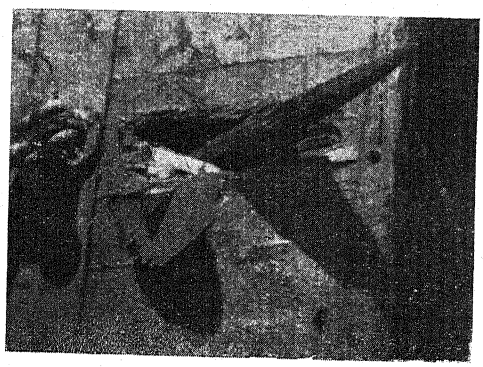

FIG. 1
The weapon *in situ*

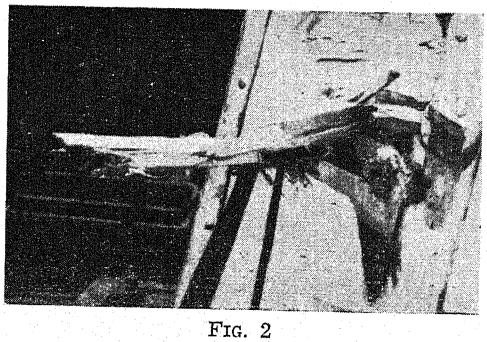

FIG. 2
The damage caused to the timber

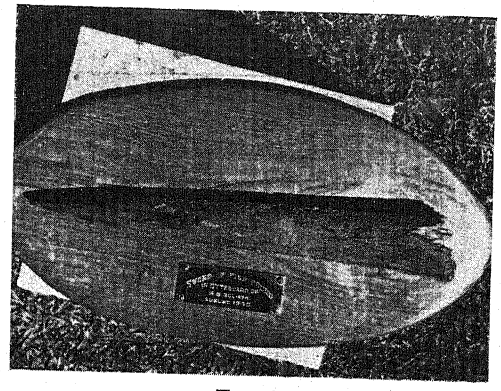

FIG. 3
The detached sword (16·1 inches) mounted on board and now placed in Head-quarters of the Ceylon Naval Volunteer Force, Colombo

The attack took place when both the fish and the vessel were moving in the same direction. There was no shoal of fish following this vessel.

C. AMIRTHALINGAM.
M. MONNINGTON.

Department of Fisheries,
Ceylon Naval Volunteer Force,
Colombo,
December 16, 1940.

[1] *Memoir of the Royal Asiatic Society of Bengal*, 1940, **2**, 215.

OUR EARTH LORE

Twice two milliard years before
Was born our Earth of fiery core;
Her infant days she suffered in vain
From burning bowels and colic pain.

For countless eons she wept in woes
And groaned, uncared, in anguished throes;
In time, hardened to chronic case
Endured she, certes, with stony face.

Her fevered core when turned to cool
Her sweat gathered in liquid pool;
In denting thus the face of Earth
These pools attained the ocean girth.

The elements fought with craggy flanks,
The rolling waves—their rocky banks;
They pounded both with powerful hands
And ground the rocks to myriad sands.

The shattered sands were whipped by waves—
In beetling cliffs, to cut dark caves;
To rush frenzied with ruthless mind,
Like maddened fiends, to mow their kind.

The hurling brooks hewed hilly-heads
And swept the clipt to ocean's ledge;
Their loads they laid in sorted beds,
Which rose later as mountain wedge.

Remained the Earth in single state
For a thousand million years, un-mate;
The smallest lives in jellied cells
Then came to crowd her ocean wells.

The land and lakes and floating cells
Were all which hailed that infant Earth;
No bouncing beasts, no flowering dells—
To rouse her face to smiles of mirth.

The weathering rage when waned a while,
The Crust cooled down to breathe a bit;
Rose then the lives in rank and file
To crowd Earth's seas then rendered fit.

Those diverse creatures, few backboned,
Did reign supreme in lake and land;
The fish and coral and three lobed crab
Out-filled those seas of old world drab.

Arose on wane of first flush life,
Which stretched in years to crores fifty,
The flowerless plants, in species rife,
And pristine, Saurian souls plenty.

Those flowerless ferns and equisitales,
Buried unwept in watery wealds,—
For ages hid in Pluto's vales,
Saw light of day as rock coal fields.

The land did groan with reptiles' reign
Through Jura's, Trias, and Chalk-age day;
Those monstrous beasts with meagre brain
Did roam and fight in spined array.

These bulky beasts of mid-life band,
Like mounts alive and dancing jig,
Hopped uncouth that dismal land
Unknown of man or small or big.

Some loathsome monsters reached such length
Their craning necks brushed moon from earth—
The tallest man beside that gang
Would look like Gulliver in Brobdingnag.

Their hideous howls were heard afar,
Their clashing dins awoke the dead,
As they bit and cut and rent in war
To pick the carrion which each one bled.

With Saurian sway the world did groan
For a hundred million years on end;
Our Earth then shook with ireful frown
And hurled the giants to direful end.

The Earth set out to heave a change
Of land and sea of mid-life age;
To raise creatures of varied range
To lead to those of Recent age.

Then Gondwan land convulsed in grief,
In molten tears its face did sear;
The Central sea did break, in brief,
Its bed to lift in mountain tier.

Those lifted mounts looked down on Ind
Of sylvan glades and monsoon wind;
The hairy mammoth and ungulate roan
Roamed these vales of sea-lift zone.

Arose varied the suckling brands
And fragrant trees of flowering kinds—
To fill the world in several lands
And wait advent of ruling minds.

Our Earth bethought of tailless one
To rule her world with erect mien,
She tried some apes and ape-like men
Of Piltdown, Peking, and Rhodesian brain.

Evolved at last the present man
With filtered blood from varied spine,
To live his life of ephemeral span—
A speck of dust in endless line.

The developed man of present race
May die away in coming days;
Lives come and go on Earth's surface
Like flecks of foam on ocean waves.

Whither, oh! whither does all this legend lead?
Does Earth evolve in heavenly ways
And fill her world with angel race,
Or shatters she like Rupert's drops
And end with grumbling, grabbing, human crops?

R. R. B.

REVIEWS

The Course of Evolution by Differentiation or Divergent Mutation rather than by Selection. By J. C. Willis. (Cambridge University Press, London), 1940. Pp. viii + 205. Price 12*sh.* 6*d.*

Natural selection as envisaged by Darwin supplied the mechanism through which it was possible to explain the course of Organic Evolution. Owing to the familiarity of the working of this mechanism it soon gained so great a footing as to enable the theory of Organic Evolution to be established in a firm and almost unassailable position. Since about the beginning of the twentieth century, however, the adequacy of this mechanism has been definitely questioned, and the author of the work under review, Dr. J. C. Willis, though trained in the strictest Darwinian School, began, as a result of his studies on tropical vegetation, to doubt its adequacy. According to him, Natural Selection, though an important factor in the Survival of the Fittest, does not offer either a satisfactory or the necessary explanation for Evolution. Since the last 35 years or so he has, therefore, been working "to find some definite laws underlying the welter of facts in distribution" of plants. The discovery of the "Hollow Curve" formed by the numbers of species in the genera of plants in the Ceylon flora in 1912 has been found by him to be of universal occurrence both in floras and faunas. This study led to the development in 1922 of his Theory of Differentiation which is associated with Age and Area, and according to which while large and "successful" genera are the oldest, the small and local ones are generally the youngest. Further there appears to be no special adaptational reason for the size or spreading of these genera. This theme was developed in the author's work *Age and Area*, but as it was a flat contradiction of the theory of gradual adaptation, it was not generally accepted by the evolutionists.

In the work under review the author describes in fair detail his "Hollow Curve", Mutation, Adaptation, Isolation, Differentiation and Divergences of Variation, and after discussing in the light of the rival theories a number of Test Cases under the headings Numerical, Morphological, Taxonomic, and Geographical Distribution, concludes that "the process of evolution appears not to be a matter of natural selection of chance variations of adaptational value. Rather it is working upon some definite law that we do not yet comprehend".

This highly suggestive and thought-provoking work is a welcome addition to the literature on Evolution, and biologists will look forward to the publication of the author's projected work on Distribution in which he proposes to deal more fully with this aspect of the subject. B. P.

The Microscope. By R. M. Allen. (Chapman & Hall, Ltd., London), 1940. Pp. viii + 286. Price 15*sh.*

In view of the relatively small number of works dealing with microscope in the English language this up-to-date work by a competent authority will be welcomed by all students of microscopy. The work is devoted to the theory and manipulation of an instrument, the uses of which have within recent years extended beyond all belief. A practical treatise on the subject for people who may not be able to understand the advanced mathematics of the optical science was, therefore, an urgent desideratum. In the work under review the author deals with the subject in a simple and easily understandable language, omitting all but the essential formulæ, but without sacrificing any important details. It would be impossible in a monograph of even twice the size to deal adequately with the multifarious phases of micro-technique, but in 7 chapters the author has succeeded in dealing with all important aspects, starting with an Historical Introduction, and passing on from Optical Principles of the Microscope, Modern Instruments, Illumination, Testing of Microscope Objectives, Getting the Most out of the Microscope, to, finally, the Preparation of the Material for Microscopical Examination. In addition to numerous illustrations in the text, 17 plates of beautifully executed half-tone reproductions of microphotographs are published to illustrate the variety of microscopic studies. A detailed bibliography of works on General Microscopy, Optical Principles, Older Works on General Microscopy and of the Objects Revealed by the Microscope, the Microscope in Specialized Use, etc., forms an appendix at the end of the work. Special mention must also be made of the very valuable glossary of about 20 pages in which various terms relating to

microscopy, the microscope, and its manipulation are explained in a very clear and concise language. Most of these terms are commonly used by microscopists, but are often a stumbling block to the uninitiated.

The work is beautifully printed, and considering the amount of matter and illustrations, is remarkably cheap at the published price of 15 shillings. B. P.

An Outline of the Mineral Resources of Andhra Desa. By C. Mahadevan, M.A., D.Sc. (Andhra University Series: No. 22, Madras), 1940. Pp. 81. Price As. 8.

Andhra Desa is endowed with an abundance of mineral wealth which is much greater than what is known of any comparable area in the Madras Presidency: the Mica mines of Nellore, the Manganese mines of Sandur, the Anantapur Gold Field and the famous Diamond fields of Golconda—all belong to Andhra Desa. Perhaps not less important is the fact that this country possesses India's best deposits of Asbestos and Barytes, in addition to having a number of other industrial minerals such as Bauxite, Graphite, Limestone, Ochres, etc.

In this "Outline of the Mineral Resources of Andhra Desa" which is based on the Andhra University Extension Lectures delivered by him in December 1936, Dr. Mahadevan introduces the subject with a brief summary of the general geological features of the country,—an introduction which helps the proper appreciation of the diversity of Geological Formations that contain within them a number of valuable minerals. This is followed by a detailed account of the occurrence of all the economically important minerals of the area, together with a large list of references which will prove useful to the prospector. A geological and mineral map of Andhra Desa on a scale of 42 miles to an inch, is also included. A chapter has been devoted to review the production of the principal minerals and to indicate the possibilities of utilizing them for several local industries. The author points out the scope which exists in the preparation of micanite sheets, the production of common salt, and the revival of indigenous iron-smelting by adopting improved appliances,—all of which are stated to be suitable for organization as small-scale cottage industries. He concludes with a strong plea for a thorough exploration of the area by qualified Geologists.

An attempt such as Dr. Mahadevan has made to take stock of the mineral position of Andhra Desa, is well worth following and it is the reviewer's opinion that if similar accounts are furnished in respect of each of the Provincial Units, they would toe the line for evolving a suitable Mineral Policy for India. M. B. R.

Practical Applications of Recent Lac Research. Edited by H. K. Sen. (The Indian Lac Research Institute, Namkum P.O., Ranchi), 1940. Pp. 75. Price Rs. 1-8-0.

This profusely illustrated and intensely practical volume on the practical applications of lac will be welcomed by all those interested in the continued prosperity and stabilisation of this exclusively Indian and time-honoured industry. Various extensions of the field of the application of lac in industry, have been rendered possible through the researches carried out at different centres in India and abroad, and the present volume is intended to promote the establishment of new lac-consuming industries.

This is unusual volume worthy of emulation by other Research Institutes in the country who are carrying on Industrial Research. If only all other institutions in the country could show the way of translating their investigations into commercially exploitable recipes, Indian research workers will, as a whole, earn the gratitude of the country which is on the threshold of a new industrial renaissance. We cannot resist the temptation of suggesting that the *Board of Scientific and Industrial Research* may issue publications of a similar character on the practical applications of the researches sponsored under its auspices. We wish to congratulate Dr. Sen on this commendable and daring venture. M. S.

Power Alcohol, Its Use as Motor Fuel in the United Provinces. By N. G. Chatterjee. (Department of Industries & Commerce, U.P., Allahabad), 1940. Pp. 17. Price Re. 0-2-6.

This pamphlet is a handy introduction to the public of general information about Power Alcohol, synonymous with "Absolute" Alcohol. The manufacture and cost of alcohol and some experiments in other countries of alcohol-petrol mixtures as motor fuel are described. Some tests with Mysore alcohol are outlined showing the volume change on mixing with petrol and comparative distillation ranges of the blends, in which gum formation does not increase, water tolerance is 0·6 to 0·9 per cent. and the Reid vapour pressure rises slightly.

The use of Power Alcohol in the U.P. is, however, nowhere described except some features of a Provincial Act of 1940 to foster the industry when it is permitted to come into existence.

It is of interest to note that in Mysore where the only Absolute Alcohol plant in India has been working, the State Act legislating for compulsory use of a 15 per cent. alcohol-petrol blend has been in force for over a year. This blend has proved a satisfactory fuel. To determine the best blend for the ordinary car and the proper working conditions for other proportions, experiments should be conducted co-ordinating Laboratory and Road tests. The results of such an enquiry by the Mysore Industrial Research Bureau are awaited with interest.

Y. K. RAGHUNATHA RAO.

Forest Research in India and Burma, 1938–39. Part I. *The Forest Research Institute, Dehra Dun.* (Manager of Publications, Delhi), 1940. Pp. 111. Price Rs. 2–14–0 or 4*sh.* 9*d.*

This annual publication summarises the work done at the Forest Research Institute, Dehra Dun; its six chapters are prefaced by a general review and followed by four appendices. The problems under investigation at the Institute are, as usual, many and varied and in addition, the report refers to the very large number of enquiries dealt with. The increasing number of such enquiries is attributed to "the impetus to indigenous industry given by the constitutional changes". This may be; at the same time, it is evidence, and welcome evidence, of the growing appreciation of the Institute's services to Indian industry. The criticism sometimes levelled that Forest research in India is divorced from the practical problems of industry would thus appear to be no longer well founded.

It is difficult to pick out individual items from this interesting although crowded report. Any selection which appear specially significant to the reviewer tends to be arbitrary. Mr. A. L. Griffith's contributions to the technique of raising teak plantations is recorded in the Sylvicultural Section. The reference to the laying of ecological quadrats in the "Controversial areas, Bamiaburu, Bihar" (p. 27) is presumably to the contour-trenching-climatic factors controversy. Under Entomology, mention is made of the "suspicious symptoms" produced by four species of insects in the sandal spike experiments but "these symptoms have not yet been transmitted by grafting". Further, the opinion is expressed that "the vector of spike disease is likely to be a species of Jassidæ associated with agricultural crops or weeds and thence intrusive in sandal forests." Under "Timber Testing", the facilities of the Institute are increasingly made use of by the aviation authorities and a report on aircraft timbers has been submitted to the Air Ministry in England. The work on "Ascu" is in progress in the "Wood Preservation Section". Special mention must be made of the experiments on wrapping papers from Ulla (*Anthristiria gigantea*) grass and it is pleasing to note that some members of the Paper Makers' Association have contributed money towards the research expenses of the "Paper Pulp Section". The Chemistry Branch gives an account of progress achieved under Drugs, Oils, Fats and Essential Oils. Work has just been begun on Forest Soils. One is rather surprised and disappointed to read that research under "Minor Forest Products" had to be greatly curtailed during the year during report *for want of funds.*

The publication is well got up and printed on paper made at the Institute from *Saccharum arundinaceum.*

A Review on the Indian Cotton Textile Industry. By H. P. Gandhi. (Gandhi & Co., Calcutta), 1940. Pp. 150. Price Rs. 3.

Mr. M. P. Gandhi has once again rendered service to the Indian Cotton Textile Industry by publishing his 1940 annual. He has arranged the information available on the Cotton Textile Industry in a comprehensive volume, which should serve as a very useful guide for those engaged in the Cotton Industry. He has followed more or less the same lines as in the past in arranging the data under various captions. As he has pointed out he was experiencing considerable difficulty in collecting statistical information on imports and exports, as official information was withheld owing to war conditions. The statistical tables are, therefore, incomplete. All the same, a review of the various tables forcibly brings home the importance of the Indian Cotton Textile industry in the national economy of India. There has been a steady increase in the number of mills, the number of active spindles, the number of active looms, number of workmen engaged in the industry and in the consumption of cotton in the past year compared with that of previous years. Table No. 15 sums up the economic position

of the industry. The figures indicated under several heads except those shown under hand-loom production are from authentic sources. They reveal that there has been a slight set-back in the past year compared with the steady progress the industry was maintaining in the past decade from year to year. Compared with 1929–30, the imports in piecegoods have fallen from 1900 million yards to 560 million yards in 1939–40, whereas the production of piecegoods in Indian mills and on hand-looms has increased from 2,290 million and 1,380 million to 3,790 million and 1,600 million yards respectively, the *per capita* consumption in the same interval varying from 15·97 to 16·5 yards during the same interval.

Mr. Gandhi has followed the same lines as in previous years in arranging the matter pertaining to the various phases of the development of the Indian Cotton Industry from its early days. He has forcibly brought out before the public, the view held by the industry that the New Indo-British Trade Agreement of 1939 is not in the best national interest and has for this purpose traced the history of the negotiations in the matter quite comprehensively.

Mr. Gandhi has also devoted much attention in presenting the difficulties that the industry was experiencing in matters connected with labour engaged in the industry in the different parts of the country and has made an impartial survey of the situation in the various provinces.

Under the caption "The Hand-loom Industry in India" Mr. Gandhi has merely mentioned the work of the Eleventh Industries Conference. In view of the importance of the hand-loom weaving industry which according to Mr. Gandhi accounts for nearly 27 per cent. of the total production of cotton goods produced in India, it is desirable to have a more comprehensive review of the industry in all its phases. Even if a detailed review of work done in each province and State, even of those to which grants are given from Government of India, can be included in future issues of Mr. Gandhi's annuals, a very useful service will be done to the industry as detailed information on each and every important phase of the cotton industry would become available.

Mr. Gandhi's review of the general conditions of the industry during 1939–40 is both instructive and convincing. After reading through the annual, one cannot resist the conclusion that the cotton textile industry of India is our largest industry, controlled, manned and financed by the nationals of the country. It is one of the few organised industries in India which the Indian industrialists have been able to develop against heavy odds, and indeed against severe competition from the industrially advanced countries. It occupies a very important position in the National Economy of India and with it the welfare of millions in this country is closely linked up.

B. K. MURTHY.

HYDROCARBON CHEMISTRY

THIS is a somewhat prosaic title to the interesting group of papers presented and discussed at the 70th General Discussion held by the Faraday Society (Gurney and Jackson, 1939, price 12*sh.* 6*d.*). To the present-day student of text-book organic chemistry and the high brow organic chemist pursuing the synthesis of vitamines, harmones, colouring matters and new medicinal chemicals, the chemistry and properties of hydrocarbons are perhaps the least inspiring. And yet the chemistry and technology of hydrocarbons presents one of the thrilling chapters in modern chemistry and none who has gone through the present monograph can lay it down without being deeply impressed by the immense importance and vast potentialities of the new synthetical methods applied to petroleum and coal. There are essentially two aspects of the subject. The first is concerned with the increasing demands for high grade aviation and automobile fuels with rising octane and cetane numbers. It is found that aromatic hydrocarbons have in general increased anti-knock characteristics and thus one of the problems is that of bulk production of aromatic compounds from the open chain raw materials available, by methods much more economical than those hitherto known for the syntheses of fine chemicals. Secondly, the various hydrocarbons, synthetic or natural, are likely to assume increasing importance as basic materials for a number of newer chemical industries, such as, to give outstanding examples only, the production of synthetic glycerol, and the new polymerisation processes for production of lubricants and plastics.

The technical development of several

phases of hydrocarbon chemistry has already reached a high standard, thanks largely to the enterprise of the petroleum technologists of America. However, our corresponding knowledge of the mechanism and theory of the reactions involved are by no means clear. This lacuna needs to be filled up, as such a basic knowledge will not only be helpful to the improvement of industrial technic, but also provide new ideas for development. The aim and purpose of the Faraday Society Symposium has been to bring together the various schools of thought for a helpful discussion and progress towards the complete elucidation of the mechanisms of the reactions.

The contributions from the notable gathering of scientists have been conveniently grouped into four main sections: I. Homogeneous thermal reactions of hydrocarbons. II. Catalytic reactions of hydrocarbons. III. The mechanism of the technical synthesis and transformation of hydrocarbons. IV. Olefine polymerisation. The significance of the several contributions has been very elegantly and lucidly brought out in an introductory paper by Prof. E. K. Rideal, who was also the President of the Symposium. In general a knowledge of the kinetics of reactions includes the elementary steps and the energies of activations. Of the large number of reacting organic molecules, the hydrocarbons lend themselves easiest to fundamental calculations of these factors and the place of honour has been given to four such contributions of "theoretical chemists". Lennard Jones and Coulson give an excellent review of the theoretical valence rules in molecules, while M. G. Evans has suggested that the low activation energy for the dimerisation and polymerisation reactions is due to the large resonance energy in the complexes formed in the transition state. Other papers in Part I deal with studies of the mechanism of thermal cracking processes, all of which, as was first emphasised by F. O. Rice, are essentially chain-like in character, a free radical like methylene being the initiator. The possible alternative methods of chain propagation and breaking have received detailed attention in these papers and the accompanying discussions.

The methods of catalysis are becoming a normal procedure in hydrocarbon industries. Such processes can be operated at a lower temperature and permit of more selective control in the nature of the products than the purely thermal reactions. Although many of the successful commercial developments have not awaited any complete understanding of the whys and wherefores of catalyst behaviour, such knowledge will doubtless be helpful for further, quicker and surer progress. Part II of the Symposium deals with the catalytic reactions of hydrocarbons. A notable contribution is that of Taylor and Turkevich who have reviewed the present position with reference to catalytic ring closure of open-chain hydrocarbons and also reported how with chromium oxide gel as a typical catalyst and normal heptane as typical paraffin hydrocarbon quantitative conversion to aromatic hydrocarbon can be secured.

In these times of Ersatz and National self-sufficiency, the synthetic production of liquid hydrocarbon fuels is one of no mean importance. In the Fischer-Tropsch process discovered as early as 1926, and since developed on an industrial scale in Germany, paraffin and olefine hydrocarbons ranging from lightest members up to solid waxes are simultaneously produced from CO and H_2, in the presence of promoted iron, cobalt and nickel catalysts, at atmospheric pressures and temperatures about 200° C. Secondly the catalytic high pressure hydrogenation of coal and oil has also been successfully developed for the production of petrol and other refined products such as lubricating oils, etc. The group of papers in Part III are devoted to the elucidation of the mechanism of these reactions. Included in this group are also some studies of the processes for the production of quality fuels of high anti-knock value, by the catalytic aromatisation of the aliphatics and by the addition reactions between saturated hydrocarbons and olefines to produce higher isoparaffins.

Polymerisation is yet another technique for extending the possibilities in the processing of hydrocarbons. A variety of products such as lubricants and plastics can be synthesised in this manner. The chemistry of growth of macromolecules of hydrocarbons is therefore of special interest and forms the main interest of the group of papers in the last section.

It is evident from the above that the contents of this volume must be of absorbing interest as much to the academic as to the technological scientists. A Faraday Society General Discussion needs no additional recommendation.

M. A. GOVINDA RAU.

SCIENTIFIC RESEARCH AND THE FUTURE OF INDIAN INDUSTRY

THIS is the title of an interesting address delivered by Prof. S. S. Bhatnagar as "The Third J. C. Bose Memorial Lecture" at Calcutta on 30th November 1940. It will be a commonplace to enumerate the many examples of what scientific research has done to industry in the world. Still a few topical illustrations may be given in order to convince the hasty capitalist who wishes to apply science to industry immediately, that a certain amount of fundamental research is essential before a discovery or invention can be exploited to its best advantage. The Society of Chemical Industry of England awarded its Perkin Medal for 1937 to Thomas Midgely for his researches which culminated in the discovery of tetraethyl lead and freon. The discovery of tetraethyl lead was the result of a series of fundamental investigations based on the original observation that elemental iodine dissolved in motor fuel in very small quantities greatly enhanced the anti-knock character of the fuel. Similarly in the development of non-toxic non-flammable refrigerents in the form of organic fluorides a logical study according to the properties of the Periodical Table was a main factor.

Not all the honours of discovery useful to industry go to chemistry. Physics shares a good many of them and occasionally with a rapidity and beauty which bewilder the chemist. One example of physics contributing to the creation of a new industry is that of the production of cold, resulting in the liquefaction of the permanent gases. The pioneering researches of Sir J. C. Bose himself on the properties of electric waves would have been commercialised immediately had only India been an industrially developed country.

If Indian researches have not been employed on a large scale, it is not because they are of no importance. This neglect is largely due to the lukewarm interest of our Government in the past in these activities, an utter lack of appreciation on the part of our industrial magnates as to the possibilities of scientific research in relation to industry and the sophisticated and too philosophical a view which the scientists themselves have taken of their discoveries. Still some progress has been made. The inspiring genius of Sir P. C. Ray enabled him to sow the seeds of Indian industry which have now blossomed forth in the shape of the Bengal Chemical and Pharmaceutical Works, Ltd., one of our largest chemical factories in India. Further industrial programmes are afoot under the ægis of the Tatas, the Governments of Mysore, Baroda and Kashmir, and others. These developments which are in the process of materialising in the near future will give a fillip to scientific research which no other movement has yet been able to impart.

As an example of what the more wide-awake nations of the world are doing for their industries, may be taken the progress which Japan has made in this direction after the China incident. The address recently delivered by Dr. K. G. Kita, Chairman of the Society of Chemical Industry of Japan, should be an eye-opener to Britain and to India. In India, several new plants are in the process of being erected and several others have already come into existence. For example, we have now in the country a plant for the manufacture of chlorine and bleaching powder, and a plant for the production of nitric acid from synthetic ammonia. A big plant for the manufacture of benzene and toluene from coal is being put up at Tatanagar, and orders have been placed for a plant for the production of aviation lubricants in N. India. However, the greatest scope for India lies in her ability to make good by indigenous production what now constitutes a shortage in industry owing to restricted imports, and this presents a vast field of investigation for the technical man and the universities. The Board of Scientific and Industrial Research and workers in the field of Industrial Research are alive to this and many investigations have been undertaken with a view to introducing the manufacture of auxiliaries in industries which have become already firmly established, as the most immediate service which research can render is to make the existing organisations equal to an emergency. Such research schemes on Scientific Instruments, Graphite, Fertilisers, Glass and Refractories, Vegetable Dyes, Cellulose, Metallurgy, etc., are being carried out under fifteen different committees. The Indian investor should also investigate the possibilities of developing uses for the raw materials whose exports were so large from the country that their disposal now constitutes

a serious problem. In this category may be mentioned the vegetable oil-seeds, bones, and skins, and leather wastes.

Scientific research in India has already achieved notable success. These cover the fields of neutral glass industry, production of large quantities of pectin at extraordinarily low prices, luminous paints of non-radioactive origin, wood treating process utilising the impregnation of naturally occurring resins, preparations of chlorinated rubber, manufacture of paints and varnishes from Bhilwan nuts, etc.

One should not forget, however, that scientific and industrial research in this country has its handicaps. We are overburdened with all sorts of tariffs and duties. Our trade and our laws are occasionally not quite helpful nor can it be said that political considerations do not come in the way of some of the investigators.

CENTENARIES

Horrocks, Jeremiah (1617–1641)

JEREMIAH HORROCKS, 'the pride and boast of British astronomy' in the words of Sir John Herschel, was born of a poor schoolmaster at Toxteth near Liverpool in 1617. He matriculated in his thirteenth year and entered the Emmanuel College, Cambridge, as a sizar. He had to leave the university before qualifying himself for a degree. Yet he determined "that the tediousness of study should be overcome by industry, my poverty by patience and that instead of a master I would use astronomical books". Having found Lansberg's *Tables* untrustworthy, he studied the works of Kepler, and Tycho Brahe, and Galileo's *Astronomical dialogues*. Finding that Kepler's numbers were incorrect, he set them right from his observations. In May 1638, he bought a telescope for half-a-crown and used it to observe the solar eclipse of 22 May 1639.

Venus in Sole visa is the title of the book in which Horrocks described his observation of the transit of Venus, thereby earning unquestioned priority for his motherland. It was published posthumously in 1672. In the course of his studies, he became convinced that a transit of Venus across the Sun, overlooked by Kepler, would actually occur in the afternoon of 24 November 1639. He announced the approaching phenomenon to his friend Crabtree and prepared to observe it by throwing upon a screen in a darkened room the image of the Sun formed by his little telescope. At 3-15 p.m. he saw with rapture the disc of Venus already entered upon the Sun. He and Crabtree were the sole observers of this unprecedented spectacle. Among the results secured by Horrock's rough measurements were corrections to the orbital elements and apparent diameter of Venus, but he hardly guessed how fundamental his observations would prove to be in the determination of the parallax of the Sun and planets.

Horrocks was also the first to conjecture that the lunar orbit should be an ellipse with the earth in one of the foci and with a varying eccentricity and an oscillating major axis. Newton afterwards showed that both the conjectures were right and were really corollaries of his theory of gravitation.

The works of Horrocks were caused to be published by the Royal Society under the editorship of Dr. Wallis. They came out in 1879 with title *Angli opera postuma*.

Horrocks died prematurely 3 January 1641.

Godfrey, Ambrose (*d.* 1741)

AMBROSE GODFREY was employed in the laboratory of Robert Boyle. He later established an independent laboratory in Southampton Street, Covent Garden. He was deputed to analyse the water of the medicinal spring at Nottington. He was elected F.R.S. in 1730. He contributed two papers to the *Phil. Trans.*, one entitled *An account of some experiments upon the phosphorus uninæ* and the other *An examination of Westashton well-waters.*

Godfrey invented and took a patent for a fire extinguisher. Godfrey's method of "suffocation and explosion" was tried 19 May 1761 in a house erected for the purpose by the Royal Society of Arts in Marlybone Fields. It is said to have proved an entire success.

Godfrey died 15 January 1741.

Huddart, Joseph (1741–1816)

JOSEPH HUDDART, a British hydrographer, was born 11 January 1741, at Allenby in Cumberland. He was educated at his parish school. Even as a boy he showed aptitude for mathematics and mechanics and constructed the model of a mill.

In 1778 Huddart entered the service of the East India Company through the good offices of his cousins who were both shipowners and holders of East India stock. As commander of the Ship "Royal Admiral" he made four voyages to the East. Meanwhile he interested himself in the survey of the coasts and ports that came under his notice, and constructed charts of Sumetra and the Indian coast from Bombay to Cocanada.

Huddart retired from the service of the East India Company in 1788. In 1791 he was elected F.R.S. Several years before, the accident of a cable parting had turned his attention to the problem of making ropes with an equal distribution of strain on the yarns. He now entered into business for the manufacture of cordage on this principle and made a handsome fortune.

Huddart died at London 19 August 1816.

S. R. RANGANATHAN.

University Library,
Madras.

SCIENCE NOTES AND NEWS

New Year Honours.—The New Year Honours list contains the names of the following men of science:—

Knighthood: Dr. S. S. Bhatnagar, Director of Scientific and Industrial Research, Calcutta; Brevet-Colonel Ram Nath Chopra, I.M.S., Director, School of Tropical Medicine, Calcutta. *C.I.E.*: Mr. A. M. Livingstone, Agricultural Marketing Adviser to the Government of India; Mr. Lionel Fielden, lately Controller of Broadcasting, Government of India; Mr. H. G. Champion, I.F.S., lately Conservator of Forests, U.P. *C.B.E.*: Lt.-Col. C. A. Maclean, I.A.S., Cane Commissioner, Bihar, and Officer Commanding the Bihar Light Horse A.F. (I). *O.B.E.*: Mr. J. R. Haddow, Indian Veterinary Service, Veterinary Research Officer, Izatnagar; Prof. S. R. Moolgavkar, Professor of Surgery, Grant Medical College, J. J. Hospital, Bombay.

The Hydrogen Bond.—The September number of the *Transactions of the Faraday Society* (Vol. XXXVI, No. 233, 1940) reports a general discussion of the Society on the "Hydrogen Bond" held on 17th May 1940 under the presidentship of Prof. E. K. Rideal, M.B.E., D.SC., F.R.S., Six papers were submitted for the session and a large number of scientists took part in the subsequent discussion. Reporting on the Hydrogen Bond in Protein structure, Astbury pointed out that proteins depend for the proper exercise of their functions, or even for their very existence, on the presence of water, of which they take up large quantities. The water that proteins take up fall roughly into two classes—the loosely bound and the tightly bound; and it is the tightly bound water that is linked by co-ordinate or hydrogen bonds with the oxygen or nitrogen atoms in the carbonyl, hydroxyl, imino and amino groups of the structure. The loosely bound or "free" water is taken up by the intermicellar spaces. The "salt-like linkages" and the "back-bone linkages" are discussed; the intermolecular hydrogen bridges are observed to show a close similarity to the backbone linkage of the extended fibrous proteins. The whole concept of polymerisation through oxygen-hydrogen-nitrogen bridges is concluded as being a generalisation of the familiar backbone linkage. Bawn, Hirst and Young, in presenting their paper on the Nature of the Bonds in Starch, discussed the characteristics of the binding between the repeating units which go to make up the macromolecule of starch. Experimental evidence in regard to the properties of the starch molecule is shown to be inconsistent with those of a structure held together by hydrogen bonds. A consideration of the kinetics of the disaggregation of starch is shown to favour the hypothesis that the repeating units of starch are bound together by normal covalent bonds as found in, for instance, the disaccharides. Sutherland summarised the main results of infra-red investigations in the study of the hydrogen bonds both intermolecular and intramolecular. Following up the same subject, Fox and Martin discussed (1) the intermolecular bonding between alcohol (and phenol) molecules forming somewhat indefinite complexes; (2) the bonds between carboxylic acid molecules leading to dimers; and lastly (3) the intramolecular association or chelation in single molecules. They pointed out that the expression "energy of the hydrogen bond" has been used in the literature with different meanings by several authors and attempted to clear up this position. Robertson presented available X-ray evidence in the formation of intermolecular hydrogen bonds in organic crystals such as α- and β-resorcinol, oxalic acid dihydrate, glycine, etc. Lastly Angus and Hill reported their investigations on the diamagnetic susceptibilities of substances capable of forming hydrogen bonds conducted in order to ascertain (*a*) if the formation of such bonds could be detected by magnetic measurements, and (*b*) whether any correlation is possible between the strength and nature of the bond and the magnetic data. These preliminary experiments seem to reveal that when formation of a hydrogen bond simultaneously involves ring formation, the susceptibility of the hydrogen-bonded structure is considerably less than the anticipated additive value and diminishes as the concentration of solute increases. On the other hand, when an "open" addition compound is formed by intermolecular hydrogen bonding between solute and solvent the susceptibility of the solute increases with solute concentration. In the discussion that followed Mrs. Lonsdale pointed out that any satisfactory study of the effect of hydrogen bonds on diamagnetism must take into account the three principal susceptibilities of molecules known to contain such bonds; at the Davy Faraday Laboratory she announced that work on these lines was already begun. The results of this investigation, which will be eagerly awaited, will be a most valuable contribution to our knowledge.

L. SIBAIYA.

Salt Accumulation in Soils and their Reclamation.—The deterioration of soils newly brought under irrigation due to the rise of salts to the surface of the soil by irrigation and the formation of alkaline soils due to the seasonal movements of soil moisture during rainfall and irrigation have formed the subject of research in the Irrigation Research Institute, Punjab, and as the result precise numerical expression has been made possible to the degree of such deterioration especially in relation to the scope for profitable reclamation of these soils (E. Mackenzie-Taylor, *Indian Farming*, 1, No. 9). The conclusions are stated as follows:—If the salt content of the soil exceeds 0·5 per cent. and the alkalinity a pH value of 9·0 then successful crops of wheat and cotton cannot be grown and only a moderate crop of rice can be grown. Secondly, if the salt content exceeds 0·5 per cent. and the alkalinity is between 9·0 and 9·2 then simple leaching will render the soil fit for

rice. Thirdly, if the salt content exceeds 0·5 per cent. and the pH value lies between 9·2 and 9·5 then the land can be economically reclaimed but the first crop of rice will be low in yield. Fourthly, if the salt content exceeds 0·5 per cent. and the pH value exceeds 9·5 then economical reclamation is impossible. For the growing of cotton in this tract it is stated that within a zone six feet in depth from the surface no portion should contain more salt than 0·2 per cent. nor the pH value exceed 8·5 for maximum yields. A. K. Y.

Manurial Experiments on Bananas.—Manurial experiments on bananas principally with a view to finding out if and to what extent potash fertilisers are advantageous which have run for a period of four years are reported by the N.S.W. Department of Agriculture, Australia (*Agricultural Gazette*, 51, Part 10). The experiments consisted of a trial of sulphate of potash at the rates of 21 lb., 41 lb. and 61 lb. per stool per year compared with no sulphate of potash. The treatments were randomised in the blocks and the blocks were repeated four times. All plots received a basal dressing of 1½ lb. of bone dust per stool per year. To test the effect of nitrogen two blocks received nitrate of soda as follows:—3 lb. per stool in the first year, 1½ lb. in the second year and ¾ lb. in the third and fourth years per stool.

The yield figures were studied statistically and it was found that the potash treatments produced no significant increases in the yield of marketable fruit in any year. There was, however, some evidence that potash increased the size of the fruit but the differences were not statistically significant.

New Uses for Indian Vegetable Oils.—Almost all the common Indian vegetable oils can be used satisfactorily as diesel engine fuel in place of mineral diesel oil, according to the Industrial Research Bureau's bulletin entitled "Indian Vegetable Oils as Fuels for Diesel Engines" which records the results of three years' investigations into the subject made at the Government Test House, Alipore, Calcutta. For this substitution, hardly any alterations are necessary to the ordinary diesel engines, and groundnut oil, cotton seed oil and rape seed oil gave the same smooth and trouble-free operation as the mineral oil. The behaviour of a number of other oils, including castor, coconut, til, mohua, kapok, karanji, punnal or undi and polang, has also been investigated. Although generally more expensive than the cheaper mineral oil, under certain circumstances they could find immediate application as engine fuels. For instance, in certain parts of the country where mineral oil is more expensive and vegetable oils are locally produced and comparatively cheaper, the latter may prove economical and useful. With the present slump in the oil export market, the prices of some of the vegetable oils have fallen. The present investigations indicate one way in which the oils can be utilized in this country, which is one of the largest producers of vegetable oils in the world. It was found that the power reduction of the engine when using these vegetable oils was practically negligible and amounted to not more than about 2 to 3 per cent. This is significant in view of the much lower calorific value of the vegetable oils, as it indicates that the heat efficiency of vegetable oils is definitely higher than that of mineral oils when used in this way.

Limestone and Marble in N. W. F. P.—The North-West Frontier Province has an almost inexhaustible source of limestone and rich deposits of good quality white statuary marble and handsome banded marbles, according to Dr. A. L. Coulson of the Geological Survey of India, whose Professional Paper on the mineral resources of the Frontier Province and the directions in which they can be developed has just been published. Dr. Coulson is of opinion that the white marble found in the Province should be carefully conserved for ornamental statuary work and the more abundant coloured varieties should be used for ordinary building purposes. The mineral production of the Frontier Province is extremely small and consists almost entirely of salt, limestone, marble and road material. There is, however, abundant power available from the Malakand Hydro-Electric Scheme and Dr. Coulson recommends that every encouragement should be given to industrial enterprises wishing to take advantage of this power. The only known deposits of coal in the Frontier Province are in the Surghar range on the border of Kohat and Mianwali (Punjab) districts. Dr. Coulson thinks that encouragement should be given for the development of the deposits as soon as the results of the survey of the area are known. Abundant deposits of gypsum are found untouched in the Kohat and Dera Ismail Khan districts. Attention can profitably be directed, says Dr. Coulson, to the utilisation of this potential economic mineral.

Shellac Floor Varnishes in America.—It is estimated that some 12,000,000 lb. of shellac, mostly prepared from seedlac imported from British India, is consumed every year in the United States of America for the preparation of floor varnishes, according to a bulletin issued by the London Shellac Research Bureau. A dozen factories are busy all the year round bleaching the seedlac to get rid of the natural orange red colour of the material. In America, where wooden floors are in almost universal use, the best methods of polishing such surfaces with the minimum of work involved in daily cleaning and maintenance generally attracted considerable attention. The method which is now widely used is the application of spirit shellac solutions. These have resisted the competition of substitutes because of the cheapness of materials from which they are made (shellac and industrial alcohol), ease of application, durability, simplicity of renewal and care-free maintenance.

War and Indian Coal.—In view of the altered position in the Mediterranean many countries in the Middle East and Near East have now

turned to India for their supplies of coal. In recent months firm demands were received from the Sudan Railways for 16,000 tons and from Palestine (Haifa) for 20,000 tons. Further demands for 25,000 tons a month were received from Greece. Hong Kong asked for 5,000 tons and orders for 30,000 tons for Port Said, Malta, Aden and Egypt were placed with Indian firms direct by the British Shipping Controller, London. Demands were also received for hard coke and gas coke from Middle East and Palestine respectively.

South Indian Epigraphy.—The collection of 471 stone inscriptions, 13 copper-plate grants belonging to the several ancient South Indian dynasties and many objects of archæological interest is mentioned in the Annual Report on South Indian Epigraphy for 1936–37 just published. For this purpose 283 villages in the Madras Presidency and 153 in the Bombay-Karnatak were visited. Besides, 91 photographs of objects of archæological interest including certain rock-cut sculptures at Pillaiyarpatti and Kunnakkudi in the Ramnad District were obtained. A few sites containing pre-historic and proto-historic remains in the Tinnevelly and Chittoor Districts were examined and burial urns and pottery were recovered.

In the South Arcot District some caverns with rock-cut beds known locally as the *Pancha-varparai* were discovered. These are similar to those found in the Pandya country and attributed to the third century B.C. Of the inscriptions collected in the Madras Presidency, the earliest are four Brahmi records going back to about third century A.D., recovered from certain ancient Buddhist sites in the Guntur District. Two of these belong to the Ikshvaku Kings, Vira Prisadata and Ehuvula Chantamula, who ruled in the Krishna valley and who are responsible for the splendid Buddhist monuments of Nagarjunikonda. Two inscriptions recovered from Srirangam near Trichinopoly are of some general interest. One records the establishment by a Hoysala general of the thirteenth century A.D. of a dispensary as an annexe to the Ranganatha temple. The other mentions the consecration in the place of an image of Dhanvantari, the Aseulapius of the Hindus.

Getting the Most from Teak Plantations.—Information of use alike to the trade and to those interested in forestry is given in a compilation on yield of teak plantations, just brought out by the Forest Research Institute, Dehra Dun, in its *Indian Forest Records*. The present publication is the first attempt at a comprehensive yield table for teak plantations throughout India and Burma.

Teak is one of the most widely distributed and economically one of the most important timber species in India. Because of the high prices that teak timber fetches as compared with the timber of its other associates in the mixed deciducus forests of India and Burma, it has been planted more extensively than any other single species. The existing teak plantations are now estimated to cover an area of roughly 300 square miles, and about 10 square miles are being added annually in India and Burma.

Schemes for Civil Industries in India.—The Government of India sanctioned more than Rs. 2,00,000 for various research schemes recommended by the Government virtually *in toto*. This grant was made for equipment for laboratories or small plants, and to cover remuneration for research workers. It was proposed to appoint for the time being two or three more research workers at the Alipore Laboratory which was to be expanded and provided with more equipment as occasion arose.

As a result of the efforts of the **Indian Chemical Manufacturers' Association, Calcutta**, the Government of India have decided to exempt *Benzol* used in the manufacture of medicinal preparations from excise duty. The Government of India levied an excise duty of annas 10 per gallon (subsequently increased to annas 12) on Benzol on the ground that it can be used as motor spirit as a substitute for petrol. The Association had pointed out to the Government that Benzol was used as a solvent in the manufacture of Alkaloid preparations but on account of the excise duty the Alkaloids prepared in India could not stand in competition with the imported Alkaloids in normal times. The step now taken by the Government of India would enable utilisation of large quantities of Benzol manufactured in coke oven plants which was till now going to waste. It would also give impetus to the manufacture of Alkaloid preparations in this country.

Indians in Malaya.—The Agent of the Government of India in Malaya in his Report for the year 1939 just published observes that rubber and tin—the two key industries of Malaya—mainly depend on immigrant labour. While the Chinese predominate in mines and factories, South Indians are employed in large numbers on rubber estates and public and Government departments mostly as unskilled labourers. At the end of 1939, the total Indian population in Malaya was nearly 745,000, forming 13·8 per cent. of the total population. About 80 per cent. of them are wage-earners engaged in some form or other of manual labour.

Despite the ban on assisted emigration to Malaya and the increase in rubber production quota which averaged 62·5 per cent. for 1939 as against 55 per cent. for 1938, there was ample supply of Indian and Chinese labour available locally to produce the full permissible quota of 75 per cent. during the last quarter of 1939. The average price of rubber, which went up to 11 to 12*d*. per lb. after the outbreak of war, was 9*d*. per lb. for 1939 as against $7\frac{7}{32}$ *d*. for 1938.

Wage rates for Indian labourers on estates which remained at the reduced level of 45 cents a day for men and 35 cents a day for women during the first three quarters of 1939, rose to 50 and 40 cents respectively with effect from October 1, 1939. Daily and monthly paid labourers and workers employed under the public authorities were granted by S.S. and

F.M.S. Governments a cost of living allowance ranging from $1 to $2 per month.

University of Mysore.—A meeting of the Academic Council was held on the 21st December 1940. Among the propositions that were passed, mention may be made of the following:—(1) Extension of the duration of the L.M.P. Diploma Course from 4 to 5 years. (2) Revision of the Course of Study for the B.A. Honours Preliminary Examination for the Social Philosophy Branch. (3) Revision of the detailed course of study in Psychology for the B.A. Honours Degree Examination. (4) Scheme of Examination in Urdu for the B.A. Honours Degree Examination. (5) Addition of Urdu to the list of subjects that may be offered for the Degree of Master of Arts. (6) Ordinance respecting the institution of the Master's Degree in Engineering. (7) Ordinances relating to the institution of the Doctorate, *viz.*, D.LITT., D.Sc., D.E., and D.Sc. (Anatomy, Physiology).

The All-India Economic Association and the All-India Political Science Association which were invited by this University to hold their Conferences at Mysore this year, met during the month. The Joint Conference of the two Associations was opened on the 28th December 1940, by His Highness the Maharaja of Mysore.

University of Calcutta.—Mr. Phanindrachandra Dutta is admitted to the D.Sc. degree, in consideration of his thesis on "Studies in the Sesquiterpene Series and Studies in the Cyclopentane Series".

Messrs. Phanindranath Brahmachari, Sunilkrishna Datta and Krishnadhan Chatterjee have been admitted to the M.D. degree on the basis of an examination.

Srimati Bibha Majumdar, the holder of Premchand Roycand Studentship in Science, will be awarded a Mouat Medal at the forthcoming Convocation of the University.

Indian Science Congress.—At the annual meeting of the General Committee of the Indian Science Congress Association held in Benares on January 6, Mr. D. N. Wadia, Mineralogist, Ceylon Government, was elected President for the 29th Session of the Indian Science Congress, which will be held at Dacca under the auspices of the University of Dacca from the 2nd to the 8th January 1942.

The following were elected Presidents for the different sections:—

Mathematics and Statistics: Prof. P. C. Mahalanobis, Professor of Physics, Presidency College, Calcutta.

Physics: Prof. B. B. Ray, Khaira Professor of Physics, Calcutta University.

Chemistry: Dr. M. Qureshi, Head of the Department of Chemistry, Osmania University, Hyderabad, Deccan.

Geology: Dr. Raj Nath, Head of the Department of Geology, Benares Hindu University, Benares.

Geography and Geodesy: Mr. George Kuriyan, Head of the Department of Geography, Madras University, Madras.

Botany: Dr. N. L. Bor, Forest Botanist, Forest Research Institute, Dehra Dun.

Zoology: Dr. H. S. Rao, Assistant Superintendent, Zoological Survey of India, Indian Museum, Calcutta.

Entomology: Dr. D. Mukerji, Zoological Laboratory, University of Calcutta, Calcutta.

Anthropology: Dr. M. H. Krishna, Professor of History and Director of Archæological Research, Maharaja's College, Mysore.

Medical and Veterinary Research: Dr. C. G. Pandit, King Institute, Guindy, Madras.

Agriculture: Dr. Nazir Ahmed, Director, Cotton Technological Laboratory, Matunga, Bombay.

Physiology: Prof. B. T. Krishnan, Professor and Head of the Department of Physiology, Medical College, Calcutta.

Psychology and Educational Science: Dr. G. Pal, Department of Psychology, Calcutta University, Calcutta.

Engineering: Mr. H. P. Philpot, Principal, Engineering College, Benares Hindu University, Benares.

At the Annual Meeting of the **Indian Academy of Sciences**, held at Waltair, in December 1940, the following were elected Office-bearers and members of the Council for the period 1940–43:—

President: Rajasabhabhushana Sir C. V. Raman. *Vice-Presidents*: (1) Lt.-Col. S. L. Bhatia, (2) Prof. K. S. Krishnan, (3) Rajasevasakta Dr. B. K. Narayan Rao and (4) Prof. Birbal Sahni. *Secretary for Section A*: Prof. B. S. Madhava Rao. *Secretary for Section B*: Prof. A. Subba Rau. *Treasurer*: Prof. B. Sanjiva Rao. *Members of Council*: (1) Dr. Nazir Ahmed, (2) Dr. S. K. Banerji, (3) Prof. S. Bhagavantam, (4) Prof. Y. Bharadwaja, (5) Prof. D. R. Bhattacharya, (6) Prof. R. Gopala Aiyar, (7) Dr. E. McKenzie Taylor, (8) Prof. S. Ramachandra Rao, (9) Dr. K. R. Ramanathan, (10) Mr. B. Rama Rao, (11) Prof. L. Rama Rao, (12) Prof. M. A. Sampathkumaran, (13) Prof. B. K. Singh, (14) Shastravaidyapravina Dr. S. Subba Rao and (11) Prof. A. V. Telang.

Sir C. V. Raman has been elected an Honorary Fellow of the Optical Society of America in recognition of his eminent services to the Science of Optics.

Indian Institute of Science, Bangalore.—The Government of His Exalted Highness the Nizam of Hyderabad have enhanced the annual grant to the Indian Institute of Science, from Rs. 2,000 to Rs. 10,000.

SEISMOLOGICAL NOTES

December 1940.—During the month one moderate and seven slight earthquake shocks were recorded by the Colaba seismographs as against two great and four slight ones recorded during the same month in 1939. Details for December 1940 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
1940		H.	M.	(Miles)		(Miles)	
December 4	Slight	18	39	4490			
9	Slight	11	40	3380			
16	Slight	15	13	2350			
17	Slight	20	12	4600			
18	Slight	11	02	4270			
19	Slight	21	19	3030			
26	Slight	04	37	1220			
28	Moderate	22	08	4750	Near 18° N., 146° E., in the vicinity of Marianne Islands in the Pacific.		

MAGNETIC NOTES

December 1940.—Magnetic conditions during the month were slightly less disturbed than those during the preceding month. There were 6 *quiet* days, 22 days of *slight* disturbance, and 3 of *moderate* disturbance as against 10 quiet days, 18 days of slight disturbance and 3 of moderate disturbance during December 1939.

The most disturbed day during the month was the 30th when a magnetic storm of moderate intensity was recorded. The day of least disturbance was the 6th. Characters of individual days are shown in the following table:—

Quiet days	Disturbed days	
	Slight	Moderate
6–8, 18, 19, 24	1–5, 9–17, 21–23, 25–29	20, 30, 31

There was one moderate magnetic storm during the month of December 1940 as against a moderate storm recorded during December 1939. The mean character figure for the month of December 1940 is 0·90, while that for the same period of 1939 was 0·77.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

Planets during February 1941.—Mercury will be visible as an evening star in the beginning of the month; it reaches greatest elongation (18° 10′ E.) on February 11 and will be stationary on February 17. After inferior conjunction with the Sun on February 21, the planet passes into the morning sky. Venus continues to get closer to the Sun and is visible as a morning star for a short while before sunrise. Mars which is still faint, is moving eastward in the southern part of Ophiuchus and will be in the constellation Sagittarius at the end of the month.

Jupiter and Saturn have both resumed their eastward motion among the stars, and continue to be conspicuous objects in the western sky in the early part of the night. The former which is moving faster, will overtake the other on February 21, when there will occur a close conjunction of the two planets, the apparent distance at the time being about a degree and a third. There will also be a close approach of the Moon to Saturn on February 3. Uranus will be found in the western border of Taurus about seven degrees to the south-west of the star cluster Pleiades.

T. P. B.

ANNOUNCEMENTS

Lady Tata Memorial Trust.—Applications are invited for Six Scientific Research Scholarships of the value of Rs. 150 per month each for the year 1941–42.

The Scholarships are open to men and women, and will be tenable for a period of twelve months commencing from the 1st July 1941. Any or all the Scholarships may be extended for a further period of twelve months, within the discretion of the Trustees. All old scholars who desire renewal should re-apply.

Applicants, who must be of Indian nationality, must be Graduates in Medicine or Science of a recognised University. They must undertake to work whole time and will be debarred from private practice. In the duration of the period of his scholarship or award the recipient of the benefit shall devote himself to the work before him to the entire satisfaction of the Trustees, who reserve the right to withhold payment on the recommendation of the Advisory Committee.

The subject of scientific investigation which they may select must have a bearing directly

or indirectly on the alleviation of human suffering by disease.

Applications must be forwarded through the Director of a recognised Research Institute or Laboratory where the candidate proposes to work and must be accompanied by a letter from the Director stating that he has critically examined the details of the proposed Research, that he approves of the general plan and that he is willing, as far as possible, to guide and direct the investigation and give laboratory facilities.

Applicants must give (*a*) a short resume on the subject indicating present state of knowledge and (*b*) details of the proposed research indicating (*i*) the methods intended to be employed, (*ii*) previous experience in the use of these methods and (*iii*) the experiments to be carried out.

Applications, which must be typed, must give full particulars in the order indicated above and must be addressed to the Secretary, THE LADY TATA MEMORIAL TRUST, BOMBAY HOUSE, BRUCE STREET, FORT, BOMBAY, so as to reach him not later than 15th March 1941.

Forthcoming Publications.—*Temperature, Its Measurement and Control in Science and Industry* (Reinhold Publishing Corporation, New York). This volume consists of about 125 papers presented at a symposium held at New York in November 1939, under the joint auspices of *The American Institute of Physics, The National Bureau of Standards, The National Research Council*, and 12 Scientific and Technical societies. About 1,300 pages and 550 illustrations. Listed price $11.00.

Scripta Mathematica takes pleasure in announcing a facsimile reprint of the 1842–1845 edition of **Peacock's *Treatise on Algebra*** in two volumes. Published at the suggestion and with the collaboration of St. John's College, Annapolis, Md. in two beautifully bound, silver-stamped volumes (Vol. I, xvi + 399 pp.; Vol. 2, x + 455 pp.).

This work, adopted as a text by St. John's College, is invaluable for every teacher of the subject. It is a "must" addition to all libraries not now in possession of the rare, original issue which has been out of print for many years.

Radio in Upper Air Investigation—(a correction).—The author regrets that an error has crept in the arithmetical calculations carried out on page 562, column 1, lines 13 to 26 in a paper of the above title published in *Current Science*, 9, No. 12, of December 1940. Those lines should be replaced by the following:—

> "Therefore, the power radiated will be 0·889 mw. Assuming 40% efficiency for the transmitter, the d.c. input works out to be 2·22 mw. Assuming 10% efficiency, it will be 8·89 mw. Taking the ohmic loss of power in the aerial, the lowering of battery voltage due to drain and lowering of temperature, etc., it is clear that a 45-V plate supply capable of delivering a few milliamperes is quite adequate. Actually satisfactory signals have been received with a 45-V plate supply."

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 88, Nos. 4570–73.
"Agricultural Gazette of New South Wales," Vol. 51, Pts. 11 and 12.
"The Nagpur Agricultural College Magazine," Vol. 15, No. 2.
"Biochemical Journal," Vol. 34, Nos. 8 and 9.
"Journal of the Institute of Brewing," Vol. 46, Nos. 3, 10 and 11.
"Journal of the Indian Botanical Society," Vol. 19, Nos. 4–6.
"Contributions from Boyce-Thompson Institute," Vol. 11, No. 5.
"Journal of Chemical Physics," Vol. 8, Nos. 10 and 11.
"Journal of the Indian Chemical Society," Vol. 17, No. 9.
"Indian Forest Records," Vol. 4A, No. 1, Silviculture.
"Transactions of the Faraday Society," Vol. 36, No. 234.
"Indian Farming," Vol. 1, No. 12.
"Health Bulletin," No. 11, Malaria Bureau.
"Bulletin of the Indian Central Jute Committee," Vol. 3, No. 9.
"Proceedings of Royal Irish Academy," Vol. 46A, 4–8 and Vol. 46B, 4 and 5.
"Review of Applied Mycology," Vol. 19, No. 10.
"Bulletin of the American Meteorological Society," Vol. 21, Nos. 7 and 8.
"Indian Medical Gazette," Vol. 75, No. 12.
"Journal of the Bombay Natural History Society," Vol. 42, No. 1.
"Journal of Nutrition," Vol. 20, No. 5.
"Journal of the American Museum of Natural History," Vol. 46, No. 4.
"Nature," Vol. 146, Nos. 3698–3702 and 3704–06.
"Journal of the Osmania University," Vol. 7, 1939 and Vol. 8, 1940.
"Indian Journal of Physics," Vol. 14, Pt. 4 (August 1940).
"Proceedings of the Royal Society of Edinburgh," Vol. 60, Pts. 2 and 3.
"Journal of Research," National Bureau of Standards, Vol. 25, No. 2.
"Canadian Journal of Research," Vol. 18, No. 9 (A.B.C.D.).
"Sky," Vol. 5, Nos. 1 and 2.
"Science and Culture," Vol. 6, No. 7.
"Indian Trade Journal," Vol. 139, Nos. 1799–1801 and Vol. 140, Nos. 1802–03.

BOOKS

1. "Catalysis, Inorganic and Organic," by Sophia Berkman, Jacque C. Morell and Gustav Egloff. (Reinhold Pub. Corpn., N.Y.; Chapman & Hall, Ltd., London).
2. "Practical Solution of Torsional Vibration Problems," second edition, Vol. 1, by W. Ker Wilson. (Chapman & Hall, Ltd., London).

CATALOGUES

Cambridge University Press, Autumn 1940, List of Books.
Edward Arnold & Co., Scientific & Technical Books, September 1940.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences:

(*Proceedings*)

December 1940. SECTION A.—P. SURYAPRAKASA RAO, P. PRABHAKARA REDDY AND T. R. SESHADRI: *Methylation of hydroxy flavonols using methyl iodide and potassium carbonate.* This reagent resembles diazomethane in the methylation of the naturally occurring flavonols. V. V. KUMARA SASTRY AND T. R. SESHADRI: *Chemical Investigation of Indian Lichens—Part II. Synthetic uses of some lichen acids.* R. D. DESAI AND W. S. WARAVDEKAR: *Studies in naphthalene series—Part V. The properties of 2-stearyl-, 2-palmityl-, and 2-lauryl-1-naphthols and synthesis of 2-octadecyl-, 2-hexadecyl-, and 2-dodecyl-1-naphthols.* R. K. ASUNDI, S. MUJTABA KARIM AND R. SAMUEL: *On the continuous emission spectra associated with electric discharges through flowing vapours of* $SnCl_2$, $SnCl_4$ *and* $SiCl_4$. P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *Paper pulp from annual crops—Part I. Rice straw.* In a straw having cellulose (Cross and Bevan) 37·5% the yield of paper pulp is about 44%. R. S. VARMA: *An infinite series involving the product of Bessel functions and generalised Laguerre polynomials.*

SECTION B.—RUSTOM JAL VAKIL: *An analysis of one hundred normal electrocardiograms (Boys aged 5 to 15 years).* C. P. ANANTAKRISHNAN and P. R. VENKATARAMAN: *The chemistry of garlic* (Allium sativum *L.*)—*Part I. The nitrogen complex.* C. P. ANANTAKRISHNAN AND P. R. VENKATARAMAN: *The chemistry of garlic* (Allium sativum *L.*)—*Part II. Phosphorus distribution.* S. V. GANAPATI: *On the occurrence of* Microspira aestuarii *in the Buckingham Canal at Madras.*

Indian Chemical Society (Journal)

September 1940.—S. S. BHATNAGAR, P. L. KAPUR AND B. D. KHOSLA: *Mechanism of the polymerisation of thiocyanogen from magnetic standpoint.* SANTI RANJAN PALIT: *Physical chemistry of resin solutions. Part II—Nature of resin solutions in organic solvents.* W. V. BHAGVAT, S. HARMALKAR AND S. S. DESHPANDE: *Mechanism of mutarotation of* d-*oxymethylene-camphor.* V. C. THAKAR, M. R. KAPADIA AND MATA PRASAD: *Determination of the space group of the crystals of* o-, m-, *and* p-*nitrobenzoic acids.* S. RAJAGOPALAN: *Synthetical experiments in the sympathomimetics. Part I—The naphthalene series.* D. K. BANERJEE: *Synthesis of* 3-(p-*hydroxyphenyl*)-*cyclohexanone.* K. S. MURTY: *The amylase activity of sweet cassava* (Mrnihot palmata). V. S. PURI AND G. C. JUNEJA: *The effect of inorganic colloids on the electrodeposition of nickel and copper.* H. N. RAY: *A new process for quantitative estimation of antimony and its separation from Tin and Lead by means of alkali sulphocyanides.*

Indian Botanical Society (Journal)

December 1940.—D. P. MULLAN: *The root-structure of* Chlorophytum tuberosum *Baker.* M. O. P. IYENGAR AND K. R. RAMANATHAN: Cladospongia, *a new member of the craspedomonadaceæ from Madras.* M. S. RANDHAWA: Zygogonium kumaoensis, *a new species of* Zygogonium *from Kumaon.* C. V. KRISHNA IYENGAR: *Structure and development of seed in* Sopubia trifida *Ham.* B. N. SINGH AND S. N. MEHRA: *The significance of anatomical changes accompanying regeneration of x-rayed* Bryophyllum *leaves.* Y. SUNDAR RAO: *Structure and development of the embryosac of* Drimiopsis kirki *Baker and* Allium govanianum Wall. T. S. RAGHAVAN AND V. K. SRINIVASAN: *A contribution to the life-history of* Bergia capensis *Linn.* T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the Bignoniaceæ. I.—Chromosome number and epidermal hydathodes in* Spathodea campanulata *Beauv.* R. E. COOPER AND D. V. SOHONEE: *The growth of the rice seedlings* (Oryza sativa *L. Columbia variety, No.* 42) *in salt solutions of different H-ion concentrations.*

December 1940.—I. BANERJI: *A contribution to the life-history of* Costus-speciosus *Smith.* V. K. SRINIVASAN: *Morphological and cytological studies in the scrophulariaceæ. II.—Floral morphology and embryology of* Angelonia grandiflora *C. Morr. and related genera.* P. PARIJA AND P. MALLIK: *Nature of the reserve food in seeds and their resistance to high temperature.* T. EKAMBARAM AND V. K. KAMALAM: *Permeability of the wall of the xylem vessel.*

Tin and Its Uses

Tin and Its Uses.—The seventh issue of this quarterly review of the International Tin Research and Development Council contains an article describing the properties of cold-reduced tinplate, and showing the advantages of the modern product over the old-style pack-rolled tinplate. Further information is given on the applications of electro-deposited tin coatings, which can be of any thickness desired. It is pointed out that articles of intricate shape can be plated in one process, and that electro-tinning is particularly useful for articles with soldered joints, which would disintegrate at the temperatures used in hot-tinning.

The protective film for tinplate, recently evolved in the Institute's Laboratories, has undergone further tests with encouraging results. A description of the process is illustrated by photographs of treated and untreated cans which have been used for meat, soup and peas. The untreated cans show considerable staining, but the treated cans appear as bright as when originally packed.

A new method for tinning copper or brass by a simple chemical process is also described in this issue, and commercial uses for the process are suggested. There are also articles on Tinned Piston Rings, and on the use of solder for correcting faults and producing smooth contours in all-steel automobile bodies. More examples of the Institute's free technical service are given, and special attention is drawn to the importance of research organisations to industry in war conditions.

SUPPLEMENT TO CURRENT SCIENCE

Vol. X] JANUARY 1941 [No. 1

CRYSTALS AND PHOTONS*

BY SIR C. V. RAMAN

MY first duty on this occasion is to express our gratitude to the authorities of the Andhra University for their generous sympathy and support to the work of the Academy and the opportunity they have afforded us of having our Annual Meeting in a truly academic atmosphere set amidst the beautiful scenery of Waltair. We appreciate very much the warmth of the welcome we have received. Our gathering here gives the Fellows of the Academy an opportunity of visiting the Andhra University at a time when many new developments are receiving attention, and of meeting men like Professor Bhagavantam, Professor Seshadri and Dr. Nagendra Nath, whose research papers have filled the pages of the *Proceedings* of the Academy and whose work has shed lustre on the University. They have, like our many other Fellows in other parts of India, given ungrudgingly of their time and energy for the welfare of the Academy. Our special thanks are due to them and other local Fellows and to the Chairman and members of the Reception Committee for having worked to make this meeting a success.

In my Presidential Address last year at Bangalore, a long-term programme of research on the physics of crystals was outlined and put forward as likely to yield valuable results for our knowledge of the solid state. Looking over the *Proceedings* of the Academy for the last twelve months, I find that fourteen papers on crystal physics (listed at the end of this address) have appeared in it, of which three are from Waltair and the rest from Bangalore. We have no reason to be dissatisfied with the progress made so far, and indeed it may be claimed that some of these papers deal with the problems of the solid state from a quite novel standpoint and open up new pathways of investigation. I propose in this address to survey broadly the field of research dealt with in these papers which may be designated as the newer crystal optics based on the ideas of the quantum theory, to distinguish it from the older optics which considers the effects of passage of radiation through crystals on the wave-principles. The quantum optics links together the phenomena observed with infra-red radiation, visible light and X-rays in a remarkable way, and reveals the existence of a new type of X-ray reflection in crystals.

* Presidential Address delivered at the Annual Meeting of the Indian Academy of Sciences held on the 27th December 1940, at the Andhra University, Waltair.

As is well known, the behaviour of a crystal with respect to common light is intimately related with the geometric symmetry of the system to which it belongs. Rock-salt and diamond, for example, which are cubic crystals are isotropic or singly refracting; calcite and sodium nitrate which are rhombohedral crystals are doubly refracting but optically uniaxial; aragonite and barite which are orthorhombic are doubly refracting but optically biaxial. These characters of the respective crystals are determined by the optical polarisability of the substance in different directions. The polarisability may be geometrically represented by a surface which is a sphere for an isotropic crystal, a spheroid of revolution for a uniaxial crystal, and an ellipsoid with three unequal axes for a biaxial crystal. The polarisability is a bulk or molar property, which is intimately connected with the atomic architecture of the crystal, that is to say, by the properties of the atoms or ions or molecules composing the crystal, and by the manner in which they are spaced, orientated and linked together. The modern techniques for growing large crystals enable us to study and exhibit the very striking optical behaviour of many common substances. Sodium nitrate, for instance, can be grown into large crystals, and a block of it shows a birefringence which is even more obvious and striking than that of calcite. Still better is naphthalene which is a biaxial crystal and shows an extremely large birefringence. *The angles of internal and external conical refraction of naphthalene are about* 14°, *and are thus eight times larger than those of aragonite with which conical refraction is usually exhibited.* Needless to say, conical refraction as observed with a piece of naphthalene is far more striking than that exhibited by aragonite. As was shown by Bhagavantam in the very first paper he published as a research student, the strong birefringence of naphthalene is closely connected with the very great optical anisotropy of the molecules as well as the special orientation of the molecules in the crystal.

The classical optics of crystals prefers to ignore the atomic architecture of the solid and regards the substance as a continuum with specific molar properties. The crystal functions as a pathway for the passage of the radiation, taking part in its propagation but remaining essentially undisturbed in the process. Even when, as frequently happens, the radiation is partially absorbed by the crystal, this is fitted mathematically into the wave-picture by making the optical constants of the substance complex quantities instead of real numbers. Such a wave-picture is a satisfactory description of the phenomena which it is intended to cover. But it is not a complete description of the facts. This was shown clearly by the studies on the scattering of light in crystals commenced by the writer in the year 1921 and culminating in the discovery of the effect of a change of frequency described in the lecture on "A New Radiation" in February 1928. The method of

observation described in that lecture involves the use of monochromatic light and a spectroscope. To take a specific example, we allow the beam of light from a mercury arc lamp to pass through a crystal of diamond. Focussing an image of the illuminated diamond on the slit of a spectroscope, we observe in the light scattered in the substance of the diamond, new lines not present in the incident radiation. Corresponding to each monochromatic line in the incident radiation, there is a second and additional line, the wave-number of which is less by 1332 per centimetre than for the incident light. A third and much feebler line of which the wave-number *exceeds* that of the incident light by 1332 per centimetre is also weakly recorded in the spectrum. Numerous such studies of the scattering of light in crystals have been made since they were first described. It is abundantly clear from the observations that they cannot be explained on the basis of the ideas of the classical wave-theory alone. It is necessary to introduce the concept of the photon or a quantum of radiation, the energy of which is proportional to the frequency of the corresponding waves. The change of frequency as actually observed appears on the quantum theory as due to an exchange of energy between the photon and the crystal, a diminution of frequency if the photon is the donor and the crystal the acceptor, and an increase if the reverse is the case.

The investigation of light scattering in crystals is a powerful method for the study of the solid state. But it is beset by peculiar experimental difficulties. Theory indicates that a perfectly homogeneous crystal would scatter no light at all; the diffusion of light theoretically possible is that due to the vibrations of the crystal lattice excited by the incident light and occurs in every case with a change of frequency. Unfortunately, however, actual crystals are far from being perfect. Internal flaws and surface imperfections result in a strong scattering of light with unaltered frequency. Theoretically this should not trouble us at all, but practically it does trouble us very much. The difficulty arises from the fact that the incident light is not truly monochromatic and usually contains additional components and some continuous spectrum. If the crystal is not clear, or if the spectrograph gives appreciable coma or scattered light of its own, there is not much hope of getting useful results. Truly monochromatic light sources, clear crystals of sufficient size with polished faces, and spectrographs of high optical perfection and illuminating power are needed for such work. When these requirements are satisfied, results of great interest and value are forthcoming.

To appreciate the significance of the results obtained in such studies, we must remember that a crystal is not a mere geometric array of atoms, molecules or ions in space, but is a coherent structure of such particles having identical properties which are held together by powerful forces, thereby

forming a rigid solid. It is inappropriate to consider the observed results in terms of the vibrations of the individual ions, atoms or molecules in a crystal. For, it is obviously not possible for any one particle in a crystal to vibrate without setting all the other particles in resonant vibration. To understand the optical behaviour of a crystal rightly, we must consider it as a whole and set ourselves to discover the various modes of vibration of which its structure is capable. These vibrations divide themselves into two classes. In the first class of vibration, we can ignore the atomic architecture of the crystal and regard it as an elastic solid traversed by acoustic waves. The frequency of such vibration may be anything from zero upwards to a value so high that the corresponding wave-length becomes comparable with the spacing of the atomic planes in the crystal. In the second class of vibration, we are dealing with movements which can only be understood or described in terms of the atomic architecture of the crystal. Such vibrations are referred to as the optical vibrations of the lattice. Some of these optical vibrations may have no counterpart at all for the substance in a fluid state and arise as a consequence of the crystal fields which bind the chemical units together into a rigid and ordered assemblage. Some of the optical vibrations, however, may have frequencies roughly corresponding to those characteristic of the ions or molecules in the fluid state. Even so, they cannot be identified with the vibrations of the individual chemical units. The optical vibrations—quite as much as the acoustic ones—are characteristic of the crystal structure and not of the individual particles present in the lattice cells.

The simplest way in which we may picture an optical vibration of a crystal lattice is to imagine the interpenetrating lattices of the simplest type present in the crystal, each carrying a single atom at the lattice points, to oscillate as rigid units relatively to each other, the centre of the inertia of the whole assembly remaining at rest. In such an oscillation, the crystal would throughout remain a homogeneous structure, but the relative positions of the atoms in its lattice cells would vary periodically with time. Such physical properties as the electric dipole moment, optical polarisabilities, and structure-amplitudes which determine the behaviour of radiation in various ranges of frequency in its passage through the crystal—would, therefore, also vary periodically with the frequency of the oscillation. It can be readily seen, however, that optical vibrations of the general description indicated would also be possible in which the phase of the oscillation changes slowly from place to place within the crystal. If this phase varies regularly in such manner as to repeat itself over a series of regularly spaced planes, the spacing of such planes is the phase wave-length of the optical vibration. An infinite phase-wave-length indicates a vibration identically the same throughout the crystal, and the optical frequency has then its limiting value.

The importance of the considerations set out above becomes clear when we consider the effect of radiations falling on a crystal. We may first refer to the case of a beam of infra-red radiation incident normally on the surface of a crystal. It is a well-known experimental fact that if the frequency of such radiation is within certain ranges characteristic of the particular substance, the radiations are powerfully reflected backwards by the crystal. This is the result of the optical vibrations of the crystal lattice being strongly excited by the incident waves. That such an excitation results in a directed reflection and not a diffuse scattering clearly indicates that the vibration of the crystal lattice is in the same phase at every point on the surface of the crystal. In the more general case of oblique incidence, in order that a regular geometric reflection may result, the excited lattice vibrations have necessarily to be coherent in phase, having everywhere the same relation to the phase of the resultant electric force due to the superposition of the incident and reflected waves. Since the waves necessarily penetrate to a certain depth, it follows that such coherence in phase must extend also into the interior of the crystal.

Passing on to the case of the scattering of light within a crystal, it is evident that an optical vibration of the crystal lattice cannot be excited by the incident light if the phase of such vibration is the same throughout the volume of the crystal. This is evident from the principle of interference, as the effects of all the secondary radiations, irrespective of their frequency, would completely cancel out. In fact, it is easy to show that a scattering of light with altered frequency within a crystal would only be possible if the lattice-vibrations have phase waves which are equally inclined to the incident and scattered waves and so spaced that the scattering is in effect a monochromatic reflection by an optically stratified medium. A very similar situation also arises when we consider the scattering of light as the result of the acoustic vibrations of the crystal lattice. The usual formula for a monochromatic reflection connects the wave-length of the incident radiation, the spacing of the optical stratifications and the glancing angle which is half the angle of scattering. This formula which follows from the classical wave-principles has its counterpart in the quantum theory, appearing as a consequence of the conservation of energy and momentum in the collision between the photon and the acoustic or optical disturbance in the crystal.

Having considered the cases of infra-red radiation, and of ordinary light, we naturally pass over to the X-ray optics of crystals. It is fairly obvious that, as in the case of ordinary light, an acoustic vibration of the lattice can only give rise to a diffuse scattering of the X-rays. The position is entirely different in regard to the optical vibrations of the crystal lattice. It follows from the very nature of an optical vibration that it does not involve any variation in the mean electronic density of a unit cell in the lattice,

but can cause only periodic variations of the structure-amplitudes of the crystal. In other words, the effect of an optical vibration is to cause a variation having its own frequency in the reflecting power of the regular crystal spacings. We may put this a little differently by stating that the optical vibration creates dynamic stratifications of electron density, and that these can give regular X-ray reflections but with a change of frequency, in much the same way as the static planes give the classical reflections without change of frequency. The spacing and orientation of the dynamic stratifications are identical with those of the static spacings when the phase-wave-length is infinite. More generally, these quantities and, therefore, also the geometric law of the modified reflection, would depend on the wave-length of the phase-waves and the angles which they make with the crystal spacings and with the plane of incidence. The geometric law of quantum X-ray reflection for the most general case has been deduced by Raman and Nath in a paper published in the *Proceedings* of the Academy for November 1940, and takes a quite simple form. It will suffice here to remark that the theory shows that the reflection should appear in precisely specifiable directions. In other words, *the spacings of a crystal should give, in addition to the classical or unmodified reflections, quantum or modified reflections obeying a different geometric law.* It is no exaggeration to remark that this new result is of the greatest importance both to X-ray optics and to crystal physics. For the experimental proof of this thesis, it is necessary that sharply defined X-ray reflections of which the positions agree with those theoretically deduced should be found in association with every crystal plane of which the structure amplitude is sufficiently large and is strongly modulated by the possible vibrations of the lattice. That this is actually the case has been demonstrated in a series of communications published during the year by Raman and Nilakantan. A specially detailed investigation for the case of diamond is appearing shortly in the *Proceedings*, which brings out in a convincing way the physical reality of the phase-waves associated with the optical vibrations of the crystal lattice. The prediction made earlier in the year that the intensity of the modified reflections given by diamond should remain unaffected at liquid air temperatures has also been completely confirmed. *The quantum theoretical character of the new reflections has thus been completely established.*

Returning to the case of the scattering of ordinary light, it may be remarked that both the acoustic and optical vibrations of the crystal lattice reveal themselves in it. The vibrations of the latter class are usually subdivided into external and internal vibrations. Though this distinction is somewhat arbitrary, it is in many cases useful; and indeed, in relation to the crystal structure, the external vibrations, the frequency of which is determined by the crystal fields and are usually much lower, are even more important

than the internal vibrations. The thermal behaviour of the external oscillations is particularly interesting. The very careful studies of the temperature effect which have been made by Nedungadi in the cases of sodium nitrate and of quartz have been very illuminating. Nedungadi's studies indicate that any transformation in crystalline form is usually *preceded* by notable changes in the magnitude and character of the low-frequency shifts. The changes observed in the case of α-quartz greatly assist in understanding the remarkable variations of physical properties which precede the α–β transformation of quartz.

The case of α-quartz has been very exhaustively investigated by Saksena with a view to identifying the various modes of optical vibrations appearing in the spectrum of the scattered light and correlating these with the known infra-red spectrum of α-quartz and with the specific heat of the crystal. The investigation must be considered to have been highly successful, as the theoretically predicted and experimentally observed behaviours show an almost complete agreement. The theoretical part of the investigation was based on an application of the methods of the group theory to the known structure of the crystal and the determination of its symmetry modes of vibration. The verification of the theoretical conclusions required an investigation of the spectra with the incident light polarised in different ways and with the crystal in different orientations, as also an analysis of the scattered light in each case. Such an investigation is naturally laborious and time-consuming, but the results in the case of quartz appear fully to have justified the trouble taken. It is very satisfactory to find from the work of Bhagavantam with calcite, and of Saksena with quartz, that the theoretical selection rules for the appearance and non-appearance of certain vibrations in the spectra are found to be obeyed. These selection rules may be deduced geometrically from the known form of the optical polarisability ellipsoid of the crystal and the character of the deformations it should undergo for vibrations of the different possible types of symmetry. The fact that the results deduced are in accord with the experimental results shows clearly that we are dealing with the vibrations of the crystal lattice and not of the individual chemical units in it, as remarked earlier in this address.

Summary

The excitation of the optical modes of vibration of a crystal lattice by radiations incident on the crystal is discussed. The optical vibrations can be described as oscillations of the interpenetrating lattices in the crystal with respect to one another. They give rise to a periodic variation of the physical constants, *e.g.*, electric dipole-moment, optical polarisabilities, structure amplitudes, which influence the behaviour of radiation in various ranges of frequency in its passage through the crystal. The phenomena observed in

the different ranges of frequency have a common feature, namely that the incident radiation excites the crystal vibrations of which the phases are everywhere in coherent relationship with the phase of the radiation field. The scattering of light or the reflection of X-rays with change of frequency appears as the result of the phase of the lattice vibrations varying from point to point in such manner that the crystal is, in effect, an optically stratified medium giving a monochromatic reflection of the incident rays at the appropriate angle of incidence determined by the spacing of the stratifications and the wave-length of the incident radiation. The description of the observed effects in the language of the wave-theory and in terms of the quantum hypothesis are complementary and do not in any way contradict each other.

The paper includes a review of 14 communications dealing with this field of research published during the year 1940 in the *Proceedings of the Indian Academy of Sciences.*

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6. S. Bhagavantam and J. Bhimasenachar — "Modified Reflection of X-rays in Crystals : Calcite."
7. C. V. Raman and N. S. Nagendra Nath — "The Two Types of X-Ray Reflection in Crystals."

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SCATTERING OF LIGHT : INFRA-RED SPECTRA

8. S. Bhagavantam .. "Effect of Crystal Orientation on the Raman Spectrum of Calcite."
9. T. M. K. Nedungadi .. "Effect of Temperature on the Raman Spectrum of Quartz."
10. B. D. Saksena .. "Raman Effect and Crystal Symmetry."
11. T. M. K. Nedungadi .. "Raman Effect in Rochelle Salt Crystals."
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13. K. Venkateswarlu .. "Raman Spectrum of Sulphur."
14. P. Rama Pisharoty .. "The Young's Modulus of Diamond."

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WAR EFFORTS AND THE KEY INDUSTRIES OF INDIA

THE rapid rise to power of countries organised in deadly earnest has been the marvel of the last decade; and the technique of warfare developed in these countries has hardly been less revolutionary than the technique of the organisation of the State. The democratic governments could only look wistfully at this war preparation of the totalitarian States, for they could not secure the whole-hearted co-operation of all sections of the people in counter-preparation until they could rouse popular enthusiasm with the slogan "our country is in danger". In India, the most important political party professed faith in complete non-violence; and the other parties have been reluctant to lend their support to additional military expenditure on the ground that so long as India remains a dependency and her sons have no effective voice in military administration, defence of India is an imperial problem of Great Britain and that Indian defence forces are no concern of the people of India. The fateful events that have followed the German conquest of the small neutral nations of Western Europe and the complete collapse of France have rudely awakened us to the danger which the victory of totalitarian States exposes us to; and there has developed a genuine interest in the war-efforts of the country. Uninformed criticism has

even swung to the opposite extreme. People are not wanting who question the adequacy of a war-effort which is intended to expand the army of this vast country by 130,000 men, when during 1914–18 nearly a million combatants were sent overseas from India. This arises from a failure to appreciate how completely 1940–41 differs from 1914–18. Then massed infantry and cavalry equipped with rifles, supported by artillery and machine-gun units and maintained by animal transport were fully competent to deal with the enemy, and were in fact the main weapons of offence. Air power was important, but was only a side-show, and the use of mechanised vehicles was in a very elementary stage. To-day, military science has been revolutionised. Riflemen are of little value unless used in co-operation with more highly technical mechanised arms. The German army easily broke through the French line by striking with armoured divisions supported by dive-bombers from air and by well-equipped machine-gun men on motor vehicles. Finally came the mass of foot soldiers to hold and consolidate the ground already gained. The adequacy of military preparations is therefore not to be judged by the recruitment of new combatants, but by the expansion of the production of modern munitions of all kinds. It has been estimated that a single active combatant in the field requires 10 tons of equipment in order that he may be effective, and that munitions include 60,000 items of materials and supplies of which India can produce only 30,000 items.

This view-point was emphasised more than a year ago in a broadcast by H. E. Sir Robert Cassels; when he lamented that India's industrial backwardness stood in the way of adequate military preparation. "India's greatest asset is a large supply of the finest types of fighting men. Her great weaknesses are a low national income and a limited industrial development, incapable as yet of supplying the technical equipment of a modern army. History has amply shown that victory is not the prerogative of a large organisation swollen with ill-armed soldiery, but rather of small well-equipped armies modern for their period. This is even more true to-day than it was at any time before, and now-a-days large ill-equipped armies are nothing more than sheep for slaughter." Indeed this difficulty was realised by the Chatfield Committee which made an exhaustive enquiry into the problems of Indian defence about three years ago. They concluded that the ordnance factories were woefully inadequate and recommended their immediate expansion at a cost of about 7 crores of rupees. The British Government even agreed to defray a part of this capital expenditure by a generous subvention. It is indeed significant that General Auchinleck, the Secretary-Member of the Chatfield Committee, should have been appointed the Commander-in-Chief in India in succession to Sir Robert Cassels. This selection justifies the belief that the programme of mechanisation together with the development of those industrial resources which are needed for defence will receive in future infinitely more attention from the Government of India than in the past.

It is no use ignoring the fact that the Indian nationalists have a grievance against the Government of India for their lack of foresight in handling problems of industrial development. Under the stress of the war

of 1914, the Government of India declared in 1915 that India was entitled to receive all the support that a Government could give in order to enable her to take a leading position among the manufacturing countries of the world. But the lessons of that war were soon forgotten. As Sir Ardeshir Dalal made a pointed reference in his Presidential Speech at the last Science Congress, the industries created by the last war languished and died in the post-war period for want of encouragement and protection from Government. It will be unfair to maintain that the Government were altogether blind to these tragic happenings. A Fiscal Commission was appointed, and in accordance with its recommendations, a policy of discriminating protection was adopted. Only those infant industries were protected which would in the long run be able to dispense with protection. The result has been that industries came into being which could command an abundant supply of raw materials and a ready market for finished products within the country itself. Thus in 1938–39, cotton manufactures stood at 920 million lbs. and cotton piece-goods at 4,200 million yards. Paper registered a production of 1·35 million cwt. in 1939–40. Match industry has maintained itself under protection, and India is producing more sugar than her current requirements. And even unhelped by tariffs, the production of cement has gone up from 1,000 tons in 1914 to more than a million tons in the current year. But we are fast approaching a limit to such expansion in the home production of consumer's goods. Indian produce such as jute, tea, cotton, hide and oil-seeds have got to seek a market abroad with the result that a trade balance has to be maintained by import of a certain minimum of consumer's goods. An increase in national income and a consequential increase in the *per capita* consumption of manufactured goods would have been a way out of the difficulty. But this unfortunately has not come to pass; and the gains from industries producing consumer's goods have been offset by the difficulties of the masses whose agricultural products are fetching lower prices and are having shrinking foreign markets.

The way out of this impasse, which is also a solution of the difficulties that are hampering our defence preparations, lies in the establishment of key industries. Adopting a division which is convenient in practice, one can speak of a category of industries and services that supply materials to other industries rather than to the individual consumer, industries that are calculated to improve the capital equipment of the country. The nation has till now been content to produce some types of consumer's goods with the aid of foreign machinery. But, from the point of view of sustained progress, the development of key industries is of paramount importance. The metallurgical industries, the engineering and machine tool industries, the chemical industries and the transportation industries broadly cover this category. In war time, the output of these industries are closely integrated with that of Ordnance and Armament factories which are directly managed by the State for the production of munitions. Leaving aside actual training of combatants, war effort becomes synonymous with expansion in the production of munitions by bringing into being these new industries or very rapid development of such of them as are already in existence.

The vision and enterprise of the Tatas have given India one key industry which is proving of incalculable value in the present crisis. Under the stimulus of the war, the Tatas have increased their production of steel in 1939–40 to more than a million tons. The Bengal Steel Corporation and the Mysore Iron and Steel Works will, between them, be soon responsible for the production of another 300,000 tons of steel. The possibilities of India as maker of steel are immense. Indian ores are rich and within easy distance of coal deposits. Limestone, dolomite, manganese and chromite are plentiful. There is no reason why India should not supply all the steel requirements of the countries represented in the Eastern Group Conference. At Jamshedpur have just been installed two five-ton electric furnaces for the manufacture of the superior quality of alloy steel required by the Defence Department, and similar steps for producing high grade steel have been taken in the Mysore Steel Works. Manufacture of armour plates which have passed the Army tests has been taken in hand and Acid Steel of superior quality has also been just produced from Indian pig iron; this successful development is likely to have far-reaching effects on the manufacture in India of locomotives, railway wheels, tyres and axles for which acid steel is specified. The manufacture of tin plate is making good progress, and the Indian Steel and Wire Products Co., are turning out 50,000 tons of bars, rods and wire nails per annum.

While India is rapidly developing her capacity for the production of iron and steel, the progress of the other metallurgical industries has been disappointing. The Indian Copper Corporation only produces a fraction of the country's requirements, while aluminium, nickel, lead, zinc, tungsten and other important metals have all been imported till now. Good deposits of nickel are stated to have been found in Nepal, but they are in areas too inaccessible for successful working. Under the stress of the war, the Government of India has promised to grant protection to the aluminium industry in future; and as a result the Aluminium Production Co. of India, Ltd., are establishing an aluminium smelter in Travancore of an ultimate capacity of 5,000 tons per year. Electric power will be supplied by the Travancore State at a very favourable rate. Steps have been taken to acquire suitable deposits of bauxite from which alumina will be manufactured locally. A sheet rolling mill for the production of aluminium sheet has also been erected near Calcutta. The increasing output of munitions of all kinds with the possibility of construction of ships, tanks, motor vehicles and aircraft in India will all make demands on the aluminium industry which, it is hoped, will be met from sources within the country. Apart from this aluminium industry in the making, no visible progress has yet been made in establishing other non-ferrous metallurgical industries.

If our progress in non-ferrous metallurgical industries has been disappointing, our progress in engineering and machine tool industries has been still more so. In 1938–39, India imported machinery and mill work worth 19 crores of rupees, instruments and scientific appliances worth 6 crores of rupees, and even belting for machinery worth 50 lakhs of rupees. Besides the railway workshops, the engineering industries are mostly located around Calcutta and Bombay and give employment to nearly

300,000 persons. They specialise in fabricating structural steel work like bridges and storage tanks, and also supply part of the country's demand for engineering stores in the textile, tea, mining and sugar industries. Small beginnings have also been made in the manufacture of workshop machines, low horse-power electric motors, transformers and electrical lamps. The Government has appointed a Director-General of Engineering Supplies with headquarters at Calcutta; and a special advisory committee has been set up to serve as liaison between Government and the Industry. The people of India are, however, suspicious that some "bottlenecks" exist in the engineering industry behind the scenes, and they are convinced that conscious purposeful direction can produce vast changes. Already there are pointers in the right direction. The growth of these industries has been largely retarded by the inadequate facilities for training of craftsmen and the limited use of apprenticeship facilities. Active remedial measures are being adopted; and schemes for the annual training of 4,000 skilled mechanics in the various technical and scientific institutes of the country at the expense of the Government of India have been sanctioned. These industries were hard hit in the slump that followed the war of 1914. Once bitten, twice shy. They have now to be created by a Government with imagination. This is a war where machines and munitions count more than men, and no extraneous interests should be allowed to hamper the attainment of India's self-sufficiency in this field. And once created for war purposes, these industries, we hope, will in peace time, convert swords into plough shares: and the future Government of India, we also hope, will not hesitate to fulfil the pledge which Sir A. Ramaswamy Mudaliar gave in March 1940: "In case we, in any form, encourage the development of industries for our war needs, we shall make it clear that at the end of the war, those entrepreneurs who had come to the assistance of the State would not be left high and dry to take care of themselves."

The heavy chemical industries of India are rapidly getting in the way of production and may soon satisfy a large part of the country's requirements. Even before the war began, most of the acids and salts were being manufactured in India. It is also welcome news that there are deposits of sulphur in Baluchistan and deposits of pyrites in Simla hills, Behar and Hyderabad, which can be drawn upon for manufacturing sulphuric acid if the foreign supply of sulphur were, for any reason, cut off. Some of the paper and textile mills are producing alkali and bleaching powder for their own requirements. With commendable vision, the Mysore Chemicals and Fertilisers have put up a plant for the production of synthetic ammonia and ammonium sulphate with a capacity of 6,000 tons a year. The Mettur Chemicals will also soon be producing large quantities of chlorine, bleaching powder and caustic soda. But the biggest development in the field has been the establishment of two factories one in the neighbourhood of Calcutta by the Imperial Chemical Industries, Ltd., and the other in Kathiawar by the Tata Chemicals, Ltd., which was started with an authorised capital of Rs. 5 crores of which Rs. 1¼ crores were issued in 1939. These huge concerns aim at producing at an early date in the country itself all our requirements of acids, alkalis, bleaching materials and artificial fertilisers, like potassium and ammonium sulphate.

It is an entirely different tale when we

consider the dye-stuff and synthetic drug industry. The import of dyeing and tanning materials amounted to 3·9 crores of rupees in 1937–38, more than 60 per cent. of the supplies coming from Germany. In September 1939, the Indian Millowners, in anticipation of war, had laid by considerable stocks of dyestuffs, and also the stock of German dyestuff in Bombay, which was confiscated, as enemy property, was found to be of very considerable magnitude. If, however, the contingency were to arise that maritime communications with Britain were seriously dislocated, practically all the dye-houses in India will have to close down. The history of the British dye-stuff industry should be an object lesson to us in our present situation. Before 1914, Great Britain did not possess a dye-stuff industry of any importance, over 90 per cent. of the dyes used being imported from Germany. As the last war progressed, the situation became very serious and it was realised that British dependence on Germany for dyes was tantamount to a much wider and more fundamental weakness of British Chemical Industry, as the production of dyes was intimately connected with the production of chemicals in general. Modern war depends for its successful prosecution on an abundant supply of an infinite variety of chemicals; and a dye-stuff and a fine chemical industry must be considered an integral part of every defence programme. The British Government took immediate and far-reaching steps. Beginning with a direct and large subsidy for the formation of a company which ultimately was absorbed in the Imperial Chemical Industries, millions of pounds were spent on the rapid development of every branch of the industry. Later on, the importation of dyes and even intermediates was prohibited. As a result, the British dye-stuff factories are now producing over 90 per cent. of their home requirements and have in addition a considerable export trade. The Government of India have just set up a plant for the recovery of toluene and benzene from coal-tar at a cost of 16 lakhs of rupees; and the Hon'ble the Commerce Member has announced that he would soon appoint an expert committee to explore the possibilities of establishing a Dye-stuff and Fine Chemical Industry in India. It is to be hoped that the Government of India will follow in the footsteps of the enlightened Government of Great Britain in this matter and that before long, this vital key industry will form a part of the capital equipment of Industrial India.

In India, the railways are either owned or controlled by the State while air transport services are in receipt of considerable subsidy. The railway workshops and the private engineering industries practically manufacture the whole of the rolling stock excepting locomotives. Sir M. Visvesvaraya lamented that no progress had been made in the manufacture of locomotives in India, even though in Mysore a metre gauge engine was built many years ago, and the railway workshops at Ajmere were capable of doing this job successfully. Under the continuous pressure of public opinion, Government decided just before the war to start manufacture of metre gauge engines at Ajmere and broad gauge engines at Kancharapara. But the war has upset these plans, as these workshops are now needed to manufacture more urgent munitions.

The Chairman of the Tata Iron & Steel Co., several years ago expressed the hope

that the steel plates manufactured at Jamshedpur might be used for ship building in the yards of Calcutta. This dream has not yet been realised. The yards at Calcutta are even now not capable of building launches and tugs of more than 1,500 tons, and manufacture of ocean-going vessels is absolutely beyond their capacity. The proposals for building shipyards have not yet received the support and encouragement which are necessary for their speedy accomplishment. The Scindia Steam Navigation Co., has however just taken up this enterprise in real earnest and in spite of the indifference of the Government is going ahead with the project of establishing a ship-building yard in the new harbour of Vizagapatam.

Nor has Indian war effort reached a stage when the ability to build aeroplanes and automobiles is considered essential. It is in these spheres, that the difference between war effort as it is and war effort as it should be, is most glaring. The Defence Department even a few months ago, was of the opinion that it was quite useless for the purposes of the present war to imagine the possibility of developments in these directions. Thanks, however, to the keen interest and the financial assistance of the Mysore State, Mr. Walchand Hirachand is putting up an Aircraft Factory in the neighbourhood of Bangalore. The American technicians in charge hope to produce aeroplanes from this factory in six months. The scheme for establishing an Automobile Industry in Bombay has not made much headway even though the project was mooted by Sir M. Visvesvaraya in 1935, and a detailed report submitted in April 1936. It was intended to manufacture 11,000 vehicles every year in a factory with a capital outlay of 2¼ crores of rupees. The Indian Industrialists are obsessed with the fear that the manufacture of motor vehicles is too difficult to be undertaken by Indian workmen in the near future. They forget however, that the thought and skill required in manufacture have been transferred from workmen to automatic machines. Russia started the manufacture of motor vehicles about 7 years ago and produced 200,000 vehicles in 1938. Immediately on the declaration of the war, the Australian Government passed a Motor Vehicle Bounty Act, which provided for a bounty of 1½ million pounds for the first 60,000 automobiles manufactured in this country. The Government of India are not yet satisfied that the proposals for a motor car industry would be conducive to war effort. There is a silver lining however, in that non-official British opinion in India is now very strongly in favour of starting these industries. In an article on the 15th November 1940. *The Statesman* urged that Indian production of aircraft, ocean-going ships and motor engines was "fundamental and inescapable, and if we fail to do these things we do so at our peril". It advocated the wholesale transference of some factories from Great Britain to India as it sometimes "ceases to be good policy to put up factories to be knocked down and to seek new sites in a small island where work is for ever being interefered with from the air". They say that great responsibilities and small minds go ill together; there is no lack of complications in Eastern Asia; and the people of India hope that in these vital matters of key industries, the decisions of the Government of India will be guided by a national outlook and by a bold, constructive and vigorous programme which will make the defences of India as invulnerable as is humanly possible.

J. C. GHOSH.

A BRIEF SURVEY OF INDUSTRIAL RESEARCH CARRIED OUT IN INDIA*

IN response to a circular issued by the Board of Scientific and Industrial Research, accounts of technical investigations completed and persued in the various laboratories in the country were received. Based on this information, the Board has compiled a useful and revealing summary of the present position with regard to industrial research.

The survey has confirmed "the view generally held that really very little new has been accomplished by teaching institutions in the way of practical applications of science". Barring a few, the universities have not concentrated on the practical applications of science to industry and in spite of the brave efforts, some of the universities have put up to make science a living reality, the finances and the preoccupation of the teachers and the researchers in matters academic, have prevented them from contributing their best to the field of industry.

During the last twelve months, however, the Board of Scientific and Industrial Research, under the inspiring and energetic leadership of Sir S. S. Bhatnagar, has sought to encourage industrial research in the universities by providing the necessary funds and personnel.

The survey has brought into prominent relief another fact which deserves careful scrutiny. In the matter of selecting problems for industrial research, no plan appears to have determined the choice. This has resulted in an unnecessary duplication of effort. Now that a central Board of Scientific and Industrial Research has been constituted, it should be possible to reorganise and promote industrial research in the country with a view to avoid any duplication of work. The Board will no doubt soon take up this task of reorganisation not only to prevent wasteful duplication but also to secure allocation and distribution of work with a view to obtain results in the shortest possible period. The availability of competent personnel and material facilities and the proximity of a related industry should constitute the principal factors in determining the most suitable centre for promoting a particular piece of research.

It would be advisable to issue periodical (half yearly) reports of the progress of these researches.

* With grateful acknowledgments to the Board of Scientific and Industrial Research.

SIR P. C. RAY'S BIRTHDAY CELEBRATIONS

AN appeal for funds to commemorate the 80th Birthday of Sir P. C. Ray has been issued under the signature of 72 prominent Indians and Europeans all over India. The appeal states, "On the occasion of the completion of the 80th year of Sir Prafulla Chandra Ray (August 7, 1941), it has been proposed by his friends, admirers and ex-pupils to raise a fund with which his name will be associated. The income of the fund will be devoted to the furtherance of scientific and industrial research in India, a cause which Sir P. C. Ray has advocated all his life". Considering the position which Sir P. C. Ray occupies in the scientific life of India, we have no doubt that the response for this appeal will be both generous and extensive.

The Commercial Museum of the Corporation of Calcutta, has decided to celebrate the Birthday of Sir P. C. Ray by organising an exhibition of chemical and pharmaceutical industries in India. An influential Advisory Board with Dr. B. C. Guha as Chairman has been formed to organise the exhibition. A special feature of the exhibition will be the practical demonstration of industrial processes worked out in various Universities and in Technological and Scientific institutions of India.

The exhibition will be opened on the 21st March, and will be kept open for a fortnight. The organisers cordially invite the co-operation of the scientists and will be glad to allot the required space for exhibits and provide all facilities for demonstrating the processes worked out by them. Communications relating to this exhibition should be addressed to Jnananjan Niyogi, Esq., Officer-in-charge, Commercial Museum, Corporation of Calcutta, College Street, Calcutta.

YAUDHEYA COIN MOULDS FROM SUNET, NEAR LUDHIANA IN THE SUTLEJ VALLEY

BY

B. SAHNI, Sc.D., F.R.S.

(*Professor of Botany, University of Lucknow*)

IN a brief note published in May 1936 I described some Antiquities from the Khokra Kot mound at Rohtak in the Jumna valley.[1] The main subject of that note was the discovery of one of the mint-sites of the Yaudheyas, and a description of the moulds in which some of the earliest coins of this famous warrior people were cast. Since then my interest in the technique of coining in Ancient India has led me, as far as time allowed, to collect all available references to ancient coin moulds found in India, with a view to write a detailed paper on the subject, which I hope to publish in the near future.

In this quest I have been fortunate enough to come across some data which seem to indicate that the ancient site at Sunet, near the modern town of Ludhiana in the Punjab, was another of the mint-places of the Yaudheyas. At this place were cast some of the later Yaudheya coins, namely, those bearing on the obverse the figure of Kārttikeya holding a spear and the Brāhmī legend

Yaudheyagaṇa-
sya jaya

and on the reverse a human figure with one arm upraised, the other held on the hip, with a ring of dots round the margin of the coin (see Figs. 1, 2). This is a well-known copper coin which I think was first figured by Prinsep[2] in 1835 and later by several others. This coin is generally assigned to the third–fourth century A.D.; in any case it is distinctly later than the coins cast in the Rohtak moulds described by me in 1936.

My evidence for regarding Sunet as a probable mint-town of the later Yaudheyas is the fact that here a considerable number of clay moulds of the type of coin just described have been found from time to time during the last fifty-six years; although, strangely enough, the real nature of these finds has so long remained obscure.

In 1884 Dr. A. F. R. Hoernle[3] exhibited before the Asiatic Society of Bengal a number of clay objects from Sunait (Sunet), all of which he referred to as "seals". Unfortunately none of these specimens were ever figured, but among them were three specimens which are of special interest to us here, and of these, luckily, Hoernle gave a very clear and detailed description, showing that they bore the obverse and reverse designs of the Yaudheya coin above mentioned. Two of them bore the reverse design and one the obverse; the impression in each case was in the negative.

Hoernle was evidently puzzled as to the purpose for which these "three exceptional seals" might have been employed; and somehow it did not occur to him that they were coin moulds. He believed that the designs must have been made by pressing actual coins into the clay before it was baked, and this may well have been the case, because coins have commonly been used as models for moulds. But in discussing the purpose for which these so-called seals were used he offered a conjecture which appeared to me needlessly far-fetched. He suggested that they may have been made by the poorer pilgrims as a cheap sort of votive tablets to escape payment for the more expensive properly stamped tablets supplied by the temple authorities. As we shall see, these supposed seals or votive tablets of Dr. Hoernle were in reality coin moulds of the Yaudheyas. In fact they were, so far as I know at present, the first coin moulds of Ancient India ever to be described.

Hoernle's originals, as stated, were exhibited before the Asiatic Society at Calcutta. Hoping that they might still be preserved at the Indian Museum I was trying to obtain a loan of them when, through a remarkable coincidence, I received in November last, from a totally unexpected quarter (namely the Bhārat Kalā Bhawan at Benares), a collection of no less than 38 clay moulds

[1] Sahni, *Curr. Sci.*, 1936, **4**, No. 11, 796–801.

[2] Prinsep, *Jour. As. Soc. Bengal*, 1835, **4**, 621–43.

[3] Hoernle, *Proc. As. Soc. Bengal.*, 1884, **53**, 137–40.

answering so exactly to the description given by Hoernle that there can be no doubt they were of the same nature. These 38 moulds also came from Sunet, but they had been discovered only within the last couple of years. Twenty-five of them had been purchased by the distinguished historian Prof. Jaya Chandra Vidyalankar at the modern village of Sunet on September 13, 1938, and the rest were similarly acquired on the spot by his pupil Mr. Amrit Pal on August 8, 1940. All these specimens are now in the Bhārat Kalā Bhawan (Museum of Indian Art and Archæology) at Benares, and I owe it to the generosity of my friend Rai Krishnadasa, founder and director of the Kalā Bhawan, and to the kind offices of Prof. Jaya Chandra, that I am here able to describe some of these interesting finds (see Figs. 3–6). I ought to add that before I had seen the Benares specimens Rai Krishnadasa was already sure that these objects were coin moulds. In fact he originally had the intention to describe them himself. That he so readily placed his material at my disposal is characteristic of him.

That the figured specimens can only be coin moulds and not seals is evident from the following facts: (*a*) There is a channel for the inflow of molten metal across the margin, clearly seen in several of the more complete specimens. (*b*) One specimen consists of two pieces still coupled together, with the remains of a clay plaster casing adhering round their outer margins, showing that the moulds were cast in a series of discs which were plastered together into a cylindrical pile. (*c*) The raised margin immediately round each coin socket has a rough, fractured surface, showing that two coupled moulds have been broken apart. (*d*) The back of each disc also has a rough, fractured surface. It is neither smooth and domed, as in many true seals, nor is it formed into a ridge to enable it to be held between the thumb and finger; nor, again, are there any string holes in any of the specimens. In most cases the back has a rough surface, suggesting that the discs were originally coupled together and were later split apart when the mould was broken up for taking out the coins.

These undoubted coin moulds from the Kalā Bhawan's collection had already convinced me that Hoernle's specimens (which I was still hoping to obtain from Calcutta) must be of the same nature. It was therefore no surprise to me when on January 10, 1941, I received through the kindness of Mr. T. N. Ramachandran, Superintendent of the Archæological Section at the Indian Museum, a number of specimens showing identically the same features as those just described. The Indian Museum moulds are in a better state of preservation; several of these are figured here for comparison with those from the Kalā Bhawan (see Figs. 7–12).

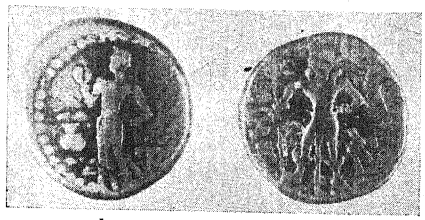
This collection from Calcutta, however, brought me a real surprise in another way. It was not the mere three specimens described by Hoernle in 1884 that Mr. Ramachandran had sent in response to my request, but a handsome series of as many as 41 coin moulds. Whether Hoernle's originals are amongst them it is not possible for me to say, because these were never figured, and there are no other indications to identify them. But after what I have said above there can be no doubt that Hoernle's pieces were of the same nature and date as those brought to light by Professor Jaya Chandra over half a century later. What is more, the fact that instead of Hoernle's three specimens so many more have now turned up from the Calcutta Museum shows that after the original find at Sunet a number of further moulds were discovered at the same locality, at a date or dates of which at present I have no information.

The suggestion is therefore not unjustified that at Sunet there must still be many more coin moulds of the same type, waiting to be unearthed, and that quite probably this modern village marks the site of a regular mint of the later Yaudheyas. A systematic enquiry on the spot, and a trial excavation of the area from where these moulds were obtained as surface finds, thus promises to be of considerable interest.

In the end, I have pleasure in expressing my sincere thanks to my assistant, Mr. R. V. Sitholey, M.Sc., who has kindly prepared all the photographs.

Postscript added 30th January 1941.—

Mr. V. S. Agrawala, M.A., Curator of the Provincial Museum, Lucknow (who has kindly read the above paper in MS.) has been able to identify the ancient name of Sunet. He writes (Jan. 25): "In the Saṁkalādi group of the sūtra IV.2.75 Paṇini, the



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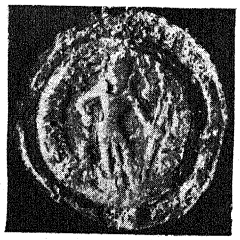

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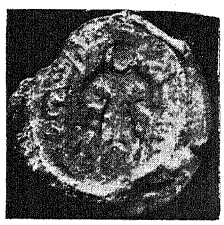

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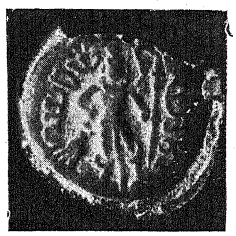

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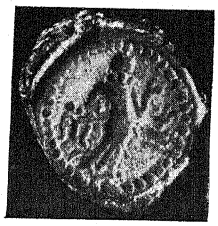

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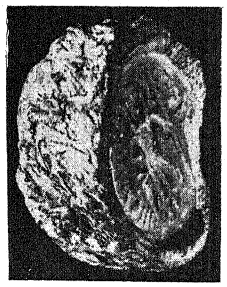

12

Figs. 1, 2. Reverse and obverse of two coins kindly lent by Mr. Jai Krishna Agrawal of Lucknow. Nat. size.

Figs. 3–6. Moulds from the Bh$\bar{a}$rat Kalā Bhawan (Benares). 3 shows a groove for the inflow of metal across the top left margin, 4 across the bottom margin; both are negatives of the obverse face. 5 and 6 show the negative of the reverse face. 6 is a double mould photographed obliquely to show the two coupled discs; the lower disc bears on its exposed face which is turned away from view a negative of the obverse. The registered numbers of the Kalā Bhawan's collection are as follows: Fig. 3 = 97·269; Fig. 4 = 97·272; Fig. 5 = 97·260; Fig. 6 = 97·266. All nat. size.

Figs. 7–12. Moulds from the Indian Museum (Calcutta). 7–10 show grooves for the inflow of metal across the top margin (7) or across the right margin (8–10). 7 and 8 are plain reverse impressions, without the objects shown in front and behind the standing figure in 11. 10 *a* and 11 *a* are positives made in plasticine from 10 and 11. 12 is a double mould photographed obliquely to show the cylinder of plaster (clay mixed with fibrous vegetable matter) round the coupled discs; the hidden lower disc shows on its exposed face not in view a negative of the reverse. Registered numbers, 7 = 9162; 8 = 9165; 9 = 9199; 10 = 9195; 11 = 9183; 12 = 9202. All nat. size.

great grammarian, reads Sunetra in a geographical context. The place founded by Sunetra would be called Saunetra and this seems the ancient name of this place ..... Sunetra according to the Mahābhārata (Ādiparva 94.61) was one of the three sons of the elder Dhritarāshtra ..... The name of the Yaudheya republic occurs in Panini's Ashṭādhyāyī and it is appropriate that he was also acquainted with the name of one of their important towns. This reference takes back the antiquity of Sunet to about 500 B.C., which point commends it as a very suitable place for further exploration".

I am grateful to Mr. Agrawala for permission to quote from his letter to me.

ALL-INDIA SOIL SURVEY

BY

B. VISWA NATH

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THE subject of All-India Soil Survey, the carrying out of which has been approved by the Imperial Council of Agricultural Research, has been under discussion in recent years.

There had been considerable expansion in the activities of Agricultural Departments of late, and with the increase in the amount of work done on soils and crops, the need for more information was felt. The subject came up for discussion by the Crops and Soils Wing of the Board of Agriculture in India, in the years 1935 and 1937 and the Board recommended that steps should be taken to carry out a soil survey of India. Following this recommendation, the Imperial Council of Agricultural Research appointed in May 1939 an *ad hoc* Committee of Soil Chemists, to make recommendations for carrying out the soil survey. This Committee reported that a large amount of published and unpublished data on soils accumulated by Agricultural Departments, and considerable useful information on soil survey and classification as adopted by Revenue Departments, were already available in the country, that soil surveys had either been carried out or had been in progress in several parts of India and that, therefore, the first requirement would be the collection and critical examination of all available data. For this purpose the Committee recommended the appointment of a standing Soil Survey Committee and the requisite staff for the collection of the existing data and for its collation and preparation for further consideration by the Soil Survey Committee. The Advisory Board and the Governing Body of the Imperial Council of Agricultural Research approved in principle the report of the *ad hoc* Committee, and it is understood that steps are being taken to implement the recommendations. This may, at first sight, appear to be an unnecessarily slow procedure but it will be realised that it is not only a sound step forward but is one calculated to expedite the survey, because it will enable the adequate appreciation of the nature of work to be done, having regard to Indian systems and conditions and of the initial difficulties to be overcome.

The problem of soil survey and soil classification in India is unique, in that it has to blend the existing classification which is in many ways sound with the modern scientific system. Soil survey and soil classification in theory and practice are not unknown to India and to some eastern countries. It is on record that the Chinese carried out a soil survey, under the orders of the Emperor of the *Yao* dynasty between the years 2357 B.C. to 2261 B.C. In India, ideas on soil classification and on crops in relation to soils appeared to exist even as early as 3,000 B.C., according to references in the *Vedas* and in the *Mahabharatha.* Kautilya's *Artha Shastra* and Abul Fazal's *Aini Akbari* provide evidence of intimate knowledge of soil classification by itself and in relation to crops, during the Hindu and Moghul periods. In this system of classification, which forms the basis of classification now current in India for land valuation and assessment, depth, colour and consistency were important considerations which closely approximate modern concepts on the subject. In most provinces in India, each village has its map showing the nature and extent of agricultural lands and areas and in addition there are available, topographic sheets for different areas published at

Calcutta by the Survey Department of the Government of India.

Leather, who was Agricultural Chemist to the Government of India, was the first in India to carry out, about forty years ago, a soil survey on scientific lines. It was a broad and comparative survey giving the composition of the well-known major soil types and his publication, in the series of Agricultural Ledgers, was in the early years a very useful source of information on Indian soils. Even in those days, Leather recorded results of examination of sections of soils and the depth disposition and composition of the soil layers which in modern terminology are called profile and horizon studies. The province of Madras was the first to undertake in 1912 systematic soil surveys and to present the data in the form of soil survey maps. The Punjab commenced surveys in 1919, and other Provinces and States soon followed. So far as is known soil surveys were completed and/or have been in progress for large tracts in the Provinces of Madras, Bombay, Bengal, the Punjab, Sind, Assam, United Provinces, Bihar, and in the States of Mysore, Travancore, Hyderabad and Limbdi. The plan and extent of the survey, as would be expected, varied in accordance with the resources and the emphasis laid on the needs and problems.

The Royal Commission on Agriculture in India examined the question fifteen years ago. Although they recognised the value of a soil survey to agriculture, they could not recommend it for two reasons. Firstly it would be very expensive, and secondly the main classes of soils and their approximate locations were known, already, and surveys were actually in progress in some provinces. They had evidently the Russian and American soil surveys in view and rightly considered that the advantages to be gained by such surveys in this country would not be commensurate with the time, labour and expense involved. The Royal Commission, however, recommended surveys of limited areas for specific purposes, such as irrigation projects.

We have thus, on the one hand, established systems of agriculture and working knowledge of soils handed down through generations of experience to the cultivator, who, if he were independent of considerations of cost, could use his art to obtain the maximum possible returns from his soils; and on the other hand, there are available accurate village maps and topographical sheets besides the empirical data available with the Revenue and Settlement Departments and the scientific data that are available with the Agricultural, and related Scientific Departments. It is true that the available scientific data were obtained in the course of routine analytical and advisory work of the Agricultural Chemists and that most of the data were obtained under the older concepts of soil analysis and by the employment of older methods which are incapable of being brought into line with modern views and methods of soil science. That should not, however, be a serious argument for rejecting the existing data without careful examination and for starting with a clean slate. For, it would raise the obvious question, whether a classification once made can or cannot be permanent over a reasonably long period and will be liable to revision, at short intervals and if the answer is that it cannot be permanent, the case for a soil survey fails. Compared to those of the temperate regions of Europe and to the comparatively recent agricultural soils of America, Indian soils have reached a state of maturity to be hardly met with in those countries. The soils in India, may in most cases be considered to have undergone almost permanent changes and adjustments in regard to their evolution processes and their relation to agricultural practices and crop production is influenced principally by water and drainage facilities and state of fertility.

The records and data that are available with the Land Records and Settlement Departments may not be found suitable for preparing soil maps on modern lines but they are likely to afford useful information on a wide basis and will certainly be valuable in giving information for check on the geographical distribution of the major soil types or zones and will also be useful in securing correlation of the modern systems and nomenclature with the local descriptive names used by the cultivators in different parts of the country and which the Land Records and Settlement Departments employ.

The ultimate object of survey is to assess soil capacity as a potent factor in the agro-industrial economy of the country. It is a part of national service to the agriculturist.

There can be two classes of soil survey. One relates to the division of soils into broad groups; the other relates to surveys of local areas. The first one has for its object the projection of important relationships which may admit correlations with the behaviour of soils in localised areas. The second is concerned with individual local areas, farms or fields. The normal procedure is to carry out the first kind of survey and then to apply the knowledge obtained from the study of broad groups in surveys of similar soils and conditions in localised areas. As it is, the position is different. We have data on the second type of local surveys. Information on broad groups is lacking. This deficiency can be partly made up by the soil studies that are now in progress at the Imperial Agricultural Research Institute. It will not be a substitute for the proposed All-India Survey but will provide useful information in the interpretation of the collected data. The work that has been in progress at the Institute is the comparative study of soils and their profiles from different parts of India, to secure a general picture of the evolutionary status of soils under varied geological and climatic influences, and for defining broad soil groups in relation to the world scheme of soil classification and in relation to cultural and fertiliser practices.

The principal aim of the preliminary work of collection and collation of data is, therefore, to bring out the more important facts from the work of the past thirty or forty years and to bring them together and then to ascertain where and what the gaps are and to determine the means of filling them. Such an assessment of the existing data will also be in the nature of preparatory work for the soil survey. It will help in knowing the problems and difficulties. As an instance in point may be mentioned the problem of textural classification in the field. Formulæ for correlating laboratory data on mechanical analysis with field behaviour have to be devised and these should be such as would agree with the local definitions of the cultivator. Field workers should be trained in naming textural classification in a manner that it correlates with that of other workers in different units in the same area and with that of workers working independently at a distance. Such are the problems to be faced and solved before the soil survey is commenced and the study of the existing data in their relation to agronomic practices should be of inestimable value as the first step in carrying out the survey.

THE FIRST ALL-INDIA PHARMACEUTICAL CONFERENCE

THE first session of the All-India Pharmaceutical Conference was held in the Benares Hindu University on the 3rd and 4th of January 1941, Mr. S. N. Bal, PH.C., M.S., Curator, Industrial Section, Indian Museum, presiding. Prominent scientists and representatives of pharmaceutical concerns from all over India attended the session.

Sir Sarvapalli Radhakrishnan, inaugurating the Conference, said that along with the social and political awakening in our country we are passing through a phase of industrial renaissance. He observed that India hitherto used to export raw materials and import manufactured drugs resulting in a great loss to the country's wealth.

In the course of his Presidential Address Mr. S. N. Bal traced the growth and development of pharmacy in the world in general and in India in particular. He deplored the serious lack of facilities for pharmaceutical education in this country, and emphasised the importance of pharmacognosy particularly to a country like India which abounds in plants of great medicinal value. Though in recent years isolated workers in different universities and medical institutions have done valuable work on certain drugs, it is still far from adequate. Amateur collectors of crude drugs bring into the market unsatisfactory plant materials, and there is an imperative necessity for a botanical garden of medicinal plants and

a herbarium. In conclusion he referred to the recent legislation to regulate the sale and manufacture of drugs but it is only when all the interested persons co-operate and the public keep a vigilant eye that the object of the Act can be realised.

Resolutions, passed at the session, refer to the recognition of the profession of pharmacy in India, drafting of a Pharmacy Bill, the compilation of an Indian Pharmacopœia, the organisation of pharmaceutical research and the control of false and misleading advertisements of medicaments.

Besides a number of scientific papers read, two symposia were held, the first of which was on the organisation of the chemical and pharmaceutical profession in India with Prof. J. C. Ghosh, Director, Indian Institute of Science, as Chairman, and the second was on the manufacture of drugs from indigenous resources with Prof. T. R. Seshadri of the Andhra University as Chairman. In the course of his address Prof. Ghosh remarked, "The war is an ill wind, but it has blown at least one good thing—the public are now keenly anxious for the proper development of a pharmaceutical industry and the proper organisation of pharmaceutical studies in the country. In olden days the apothecary used to make in a shop all the pills, tinctures and extracts which the physicians prescribed, but the base of most of these pharmaceutical operations has now been transferred from the apothecary's stores to the factory of the drug manufacturer; it is here that the chemist and the pharmacist meet." He then referred to the Drugs Act and the proposed Pharmacy Act and pointed out how they would create a continual demand for highly trained pharmaceutical chemists.

In the discussion that followed, the need for safeguarding the interests of the chemical and pharmaceutical profession and for the recognition of the primary importance of the chemist in drug and food control and standardisation of laboratories was emphasised. Unfortunately there has been a tendency to over-emphasise the place of pharmacology in the analytical laboratories of our country. The formation of a permanent committee on the lines of the *Chemical Council of Great Britain* was suggested.

Introducing the symposium on the manufacture of drugs from indigenous sources, Prof. Seshadri pointed out that though the present time may be said to be the most propitious for the rapid development of a drug industry in India, the response from industrialists including capitalists and technologists has been comparatively poor. A guarantee that the present demand by the Government and the public for drugs manufactured in India will continue and that legitimate protection against outside competition will be given after the war, is needed for providing the necessary stimulus for large-scale drug production in the country. A protected drug supply is as important to the health of a community as a protected water or food supply. No famine in these essential requisites or blockades can be allowed. He then discussed how the Government, the industrialists, the scientists, the universities, the politicians and the public can play their part for the rapid development of the drug industry.

During the discussion, a review of the present achievements in drug manufacture and drug control in India was made, attention being drawn to the excise difficulties and heavy freight charges and certain inconvenient regulations in the supply of some raw materials and to the need for greater attention for the fabrication of manufacturing units.

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INTERACTION OF ATOMIC ENERGY LEVELS

The present investigation is a continuation of the work we have already reported,[1] undertaken with a view to obtain information regarding the mutual influence of atomic energy states. The general method is to excite the spectra of two elements and then the spectrum of their mixture, all under identical conditions; a comparison of the relative intensities of the lines in the spectra of the individual elements with the relative intensities of the same lines in the spectrum of the mixture gives the required information.

Winans and Williams[2] have compared the relative intensities of tin lines obtained from a carbon arc containing tin with those from a Tesla discharge through a tube containing tin and mercury, when the latter was irradiated by λ2537 of Hg. The dispersion used by them was very small. In our experiments the spectra of the individual elements and of their mixture have been obtained under similar conditions for all, and the dispersion employed is quite large.

Results

The lines of tin and mercury that suffered modification in intensity by mixture are given below:—

Tin Lines

Strengthened:

2839·99	$5p^2\ {}^3P_2 - 5p6s\ {}^3P_2^\circ$
2850·61	$5p^2\ {}^1D_2 - 5p5d\ 1_2^\circ$
3034·12	$5p^2\ {}^3P_1 - 5p6s\ {}^3P_0^\circ$
3175·04	$5p^2\ {}^3P_2 - 5p6s\ {}^3P_1^\circ$
3262·33	$5p^2\ {}^1D_2 - 5p6s\ {}^1P_1^\circ$

Weakened:

2317·21	$5p^2\ {}^1D_2 - 5p6d\ 4_3^\circ$
2334·80	$5p^2\ {}^3P_1 - 5p5d\ 3_1^\circ$
2354·84	$5p^2\ {}^3P_1 - 5p5d\ 2_2^\circ$
2421·69	$5p^2\ {}^1D_2 - 5p5d\ 11_3^\circ$
2429·49	$5p^2\ {}^3P_2 - 5p5d\ 4_3^\circ$
2483·5	Sn II.
2495·72	$5p^2\ {}^1D_2 - 5p5d\ 9_2^\circ$
2546·55	$5p^2\ {}^3P_0 - 5p6s\ {}^1P_1^\circ$
2571·60	$5p^2\ {}^1D_2 - 5p6d\ 6_3^\circ$
2594·43	$5p^2\ {}^1D_2 - 5p6d\ 5_2^\circ$
2661·25	$5p^2\ {}^3P_1 - 5p6s\ {}^1P_1^\circ$
4524·74	$5p^2\ {}^1S_0 - 5p6s\ {}^1P_1^\circ$

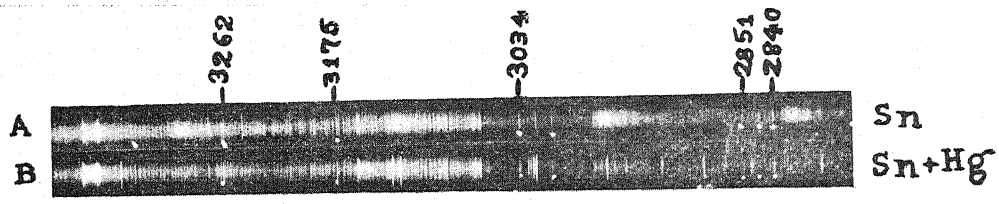


FIG. 1

A—Tin
B—Tin and Mercury Mixture

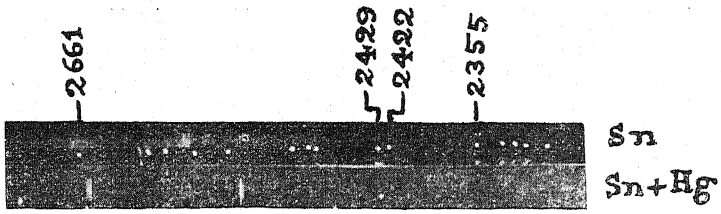


FIG. 2

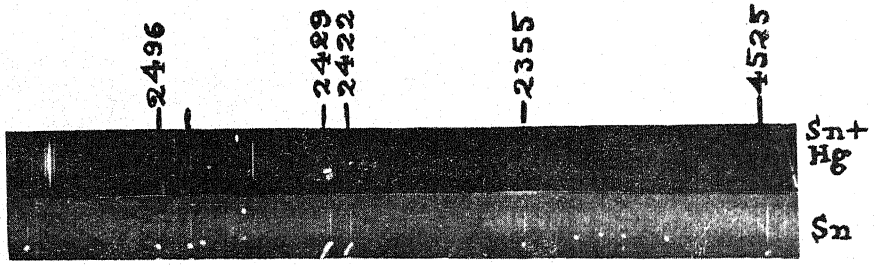


FIG. 3

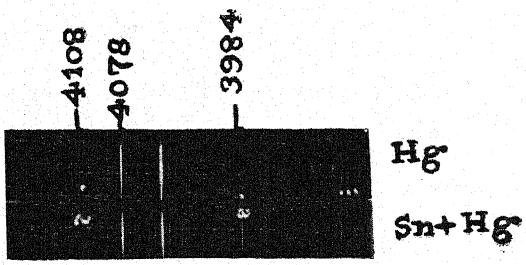


FIG. 4

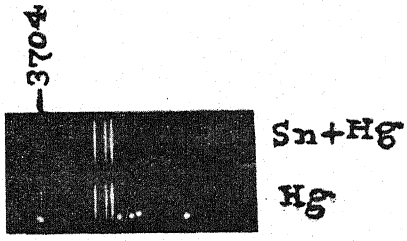


FIG. 5

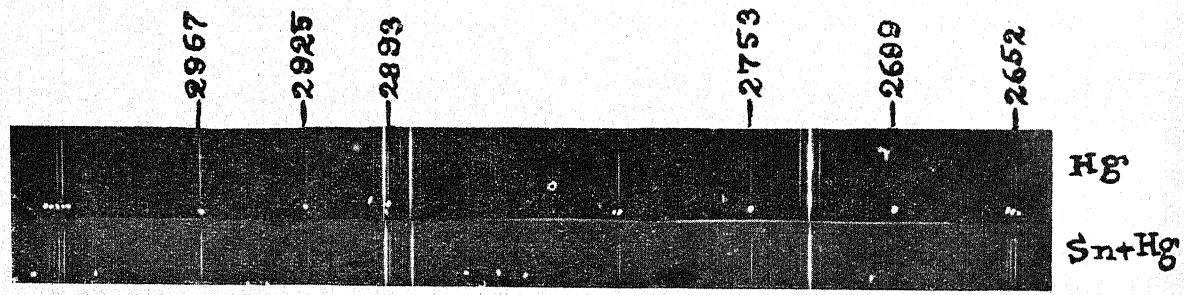


FIG. 6

MERCURY LINES

Strengthened:

2464·02	$6^3P_0 - 9^3S_1$
2536·52	$6^1S_0 - 6^3P_1$
2652·04	$6^3P_1 - 7^3D_2$
2653·68	$6^3P_1 - 7^3D_1$
2655·13	$6^3P_1 - 7^1D_2$
2752·77	$6^3P_0 - 8^3S_1$
2856·94	$6^3P_1 - 8^1S_0$
2893·62	$6^3P_1 - 8^3S_1$
2925·41	$6^3P_2 - 9^3S_1$
2967·28	$6^3P_0 - 6^3D_1$
3983·96	Hg II
4077·83	$6^3P_1 - 7^1S_0$
4108·08	$6^1P_1 - 9^1S_0$

Weakened:

2400·52	$6^3P_1 - 9^1D_2$
2639·93	$6^3P_2 - 10^3D_3$
2698·85	$6^3P_2 - 9^3D_{2\|3}$
3704·25	$6^1P_1 - 9^1D_2$

DISCUSSION

In considering the explanation for these facts we must take into account the processes that occur in the discharge tube. Mercury and tin atoms are being raised to excited levels by electron impacts and there are also impacts between normal and excited tin and mercury atoms. Of these impacts, those involving atoms in metastable states are of greater interest. Now mercury has two metastable levels at 37642·3 and 44040·2 cm.$^{-1}$ respectively above the ground state and tin has four such levels at 1692·0, 3428·0, 8613·5 and 17163·0 cm.$^{-1}$ respectively. Now all the tin lines that are strengthened have upper levels near the two metastable levels of mercury as can be seen from the previous table. Hence their strengthening must be explained as due to impacts of normal tin atoms with metastable mercury atoms in which the latter give their energy to the former. The brightening of the tin lines may also be due to impacts of normal tin atoms with mercury atoms in the $6\,^3P_1$ state, but this process does not seem to be very frequent since 2536 ($6\,^3P_1 - 6\,^1S_0$) is brightened instead of becoming weaker. This strengthening of 2536 must be due to increased production of the $6\,^3P_1$ state by impacts with tin atoms in the $5p6s\,^1P_1^\circ$ state. The energy of the latter state is very close to that required to excite $6\,^3P_1$ and two tin lines having that state as the upper level have become weaker. But 3262 of tin which involves the same upper level is brightened. This must be explained by the fact that for this line the transition probability being larger, the transition takes place before the energy of the upper state is destroyed by collisions. Taking the upper states of the other tin lines which have been weakened, we find that they have energies near 44000, 47000, 49000 and 52000 cm.$^{-1}$ The first of these may be used up in producing metastable mercury atoms in the $6\,^3P_2$ state. The other energies when added to the energies of the $6\,^3P_0$ metastable state of mercury amount to 82000, 85000, 87000 and 90000 cm.$^{-1}$ respectively and are quite sufficient to ionise the mercury atom (energy required for ionisation $84178·5 = \text{cm.}^{-1}$). That such ionisation does take place seems to be corroborated by the strengthening of the mercury spark line 3984. The four lines of mercury which are weakened have upper states of energy about 81000 which when enriched by impacts with metastable tin atoms particularly in the $^3P_2$ state (3428 cm.$^{-1}$) will lead to the ionisation of the mercury atom. This serves to explain why the corresponding mercury lines are weakened. As for the mercury lines which are strengthened, we have already explained the strengthening of 2536. Taking the others we find the enriched upper levels having energies of 64000, 71000, 74000, 77000 and 78000 cm.$^{-1}$ respectively. These states must arise from mercury atoms taking up the requisite energy from tin atoms. The probable states can only be guessed. Mercury atoms in the $6\,^3P_2$ state taking the energy of the metastable $^1S_0$ state of tin lead to an energy equal to 61000 cm.$^{-1}$ The $6\,^3P_0$ state of mercury by taking the energy of tin atoms in the $^1P_1^\circ$ state can be raised to a level = 77000 cm.$^{-1}$ Mercury atoms in the $6\,^1P_1$ state can, by taking the energy of tin atoms in the metastable $^1D_2$

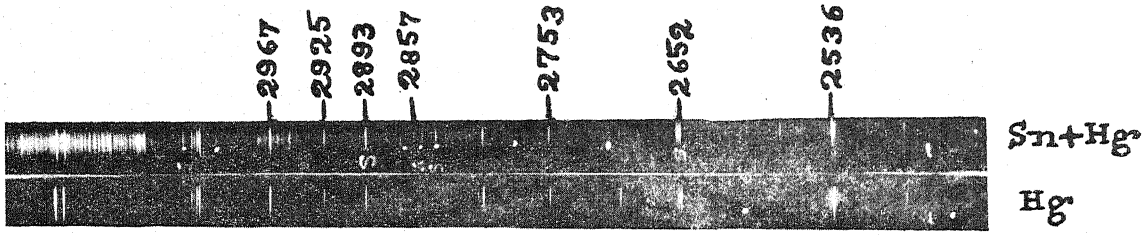


FIG. 7

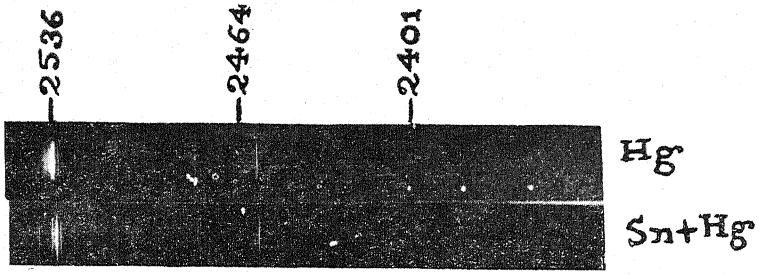


FIG. 8

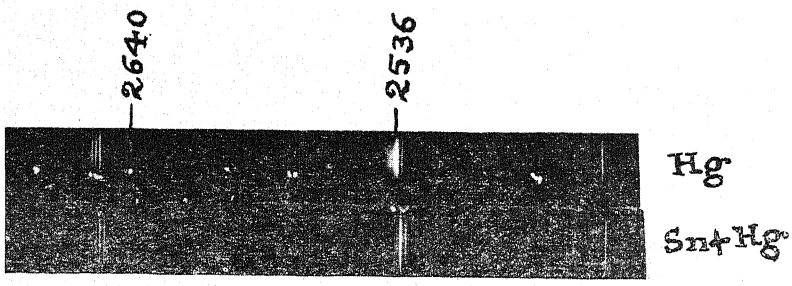


FIG. 9

state, be raised to 63000 cm.$^{-1}$ while, by taking energy from the metastable $^1S_0$ state of tin, they can be raised to 71000 cm.$^{-1}$ Whether these processes actually occur cannot be further corroborated by our experiments, since transitions from the $6\,^1P_1$ state are beyond the range of our instruments. Other mercury levels near 77000 cm.$^{-1}$ also do not give lines accessible to our observation. Some mercury lines such as 3663, 3654 and 3651 Å, as well as 5791, 5789 and 5770 Å do not show any appreciable change in intensity although their upper levels are near 71000 cm.$^{-1}$ Such preferential interaction of levels, leading to changes in the population of some levels and none in other levels very close to the first, occurs also in the other mixtures studied by us. The regularities underlying such preferential interaction can only be perceived when much more extensive data have been accumulated, but a tentative explanation may be offered by noting that the transition probabilities for the lines 3650, 3654, etc., are larger than those for 2967 and hence there is a greater chance for 2967 to be affected.

In conclusion, it is a pleasure to record our thanks to Professor A. Venkat Rao Telang for much encouragement and many facilities.

T. S. SUBBARAYA.
K. SESHADRI.
N. A. NARAYANA RAO.

Physics Department,
Central College,
Bangalore,
January 27, 1941.

[1] *Curr. Sci.*, 1939, **8**, 508; 1940, **9**, 14; 1940, **9**, 173.
[2] *Physical Review*, 1937, **52**, 930.

A NEW (2 → 2) BAND IN THE SPECTRUM OF THE *OD* MOLECULE

In an attempt to search for *OD* in the solar spectrum, photographs have been obtained of the band λ3065 and the adjacent regions with different exposures. The spectrum in this region consists of a number of overlapping bands which degrade to the red. The $\Delta v = 0$ sequence lies mostly in this region, the origin of the (0 → 0) band falling within a few wave numbers of that of the corresponding *OH* band. The high initial purity of the sample of heavy water produced a spectrum entirely free from any trace of *OH* bands. The method of excitation was similar to that described by Rao and Sastry[1] and the same spectrograph was employed for photographing the spectrum. With this type of discharge tube the background radiation was greatly reduced.

Precision measures of wave-lengths of about 200 lines in the region between λλ3100–3250 have been made. Among these are about *90* lines which form the six principal branches of a new (2 → 2) band. The relative intensities of the lines in the several branches of this band have been studied from microphotometric traces. The rotational term differences obtained from these branches are used to evaluate the molecular constants. The agreement between these and similar values derived by Rao and Sastry from the (2 → 1) and (3 → 2) bands justifies the quantum assignment.

A study of the lines of the (0 → 0), (1 → 1), and (2 → 2) bands for possible solar correlations has been made. A complete description of this work will be published shortly.

A. L. Narayan.

Solar Physics Observatory,
Kodaikanal,
January 1941.

[1] Rao and Sastry, *Curr. Sci.*, 1940, **9**, 225.

A NOTE ON COAGULATION OF COLLOIDS BY BI-METALLIC JUNCTIONS

When a potential is established colloid particles migrate and flocculate at the poles. Even a slight potential is considered sufficient. In the present experiments the effect of bi-metallic junctions on coagulation of colloids have been studied.

An iron-aluminium couple was prepared by dipping a freshly cleaned piece of aluminium foil in a warm concentrated solution of ferric chloride. An adherent deposit of iron on the aluminium surface was obtained if the replacement was not allowed to proceed too far. The couple was washed completely free from all adhering electrolytes and then introduced into an arsenic sulphide sol. A remarkably rapid coagulation of the sol was observed. The coagulation always proceeded from certain active points on the couple and soon definite streaks of coagulated particles became visible. In fact coagulation occurs most at the points where the active hydrogen is most vigorously evolved. A number of different colloidal solutions have been studied with various couples. Nearly all negatively charged sols are rapidly coagulated.

A detailed study has shown that the coagulation is not entirely due to the electrical potential. The experiments of Biltz[1] have been repeated and it has been found that definite quantities of metallic ions are generated by dissolution of the metal electrodes in the slightly acid medium of the sol. The flocculation of sols by couples, as described here, is largely due to electrolyte coagulation. During the coagulation of an arsenic sulphide sol by the iron-aluminium couple, definite tests for aluminium were obtained in the fluid of the colloid.

The peculiar feature of this method of coagulation, however, is that the disturbing influence of the conjugate ion which is unavoidable during electrolyte coagulation, is largely absent. This process thus affords a truer method of studying the Schultz-Hardy law for coagulation by metallic ions. A detailed report will be published soon.

P. B. Ganguly.

Physico-Chemical Laboratory,
Science College, Patna,
December 20, 1940.

[1] *Zeitt. Electrochem.*, 1908, **14**, 567.

MAGNETIC SUSCEPTIBILITY OF IODIC ACID IN AQ. SOLUTION (CONSTITUTION OF IODIC ACID)

IN a previous communication to *Current Science*[1] and in a detailed paper[2] it was pointed out that in the case of aqueous solutions of Iodic acid a number of properties, *e.g.*, density, viscosity, parachor, refractive index, temperature coefficient of conductivity, all showed a remarkable similarity in their curves which exhibited breaks at 0·04 N and 0·09 N.

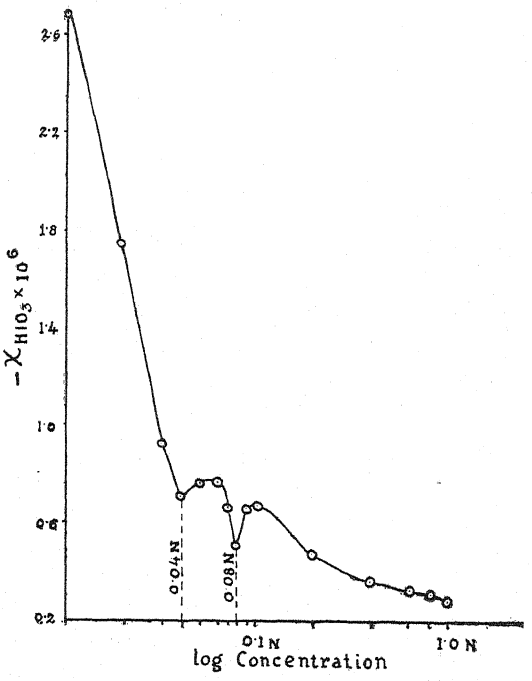
In the present investigation the magnetic susceptibility of the aqueous solution of the acid at different concentrations has been measured, and the mass susceptibility determined and plotted against concentration. The susceptibility measurements have been carried out previously by S. R. Rao and Sriraman[3] by means of a Curie balance at concentrations ranging from 17 per cent. to 76 per cent. from which they concluded that "no systematic variation was obtained when the concentration was varied". In our case we used a modified form of Decker's balance with a special device for temperature control. The region of concentration investigated was between 0·01 N and 1·0 N, that is, below that of the previous workers. The following formulæ were used to evaluate firstly the susceptibility of the solution, and from that the mass susceptibility of the solute:—

$$(1)\quad \chi_{sol}\cdot\rho_{sol} = \chi_w\cdot\rho_w + (\chi_w\cdot\rho_w - \chi_a\rho_a)\cdot\frac{\theta_w-\theta_{sol}}{\theta_a-\theta_w}$$

$$(2)\quad \chi_{sol} = C_s\cdot\chi_s + (1-C_s)\chi_w$$

where χ_{sol}, χ_w, χ_a are the susceptibilities of the solution, water and air, ρ_{sol}, ρ_w, ρ_a are the densities of the solution concerned, water and air, and θ_{sol}, θ_w, θ_a are the deflections for solution, water and air respectively, and in the second equation C_s is the concentration, χ_s the mass susceptibility of the solute, and χ_w the mass susceptibility of water.

It will be observed that the curve shows two breaks at 0·04 N and 0·08 N. These correspond remarkably well with similar breaks in the curves obtained with other properties and were explained as due to transition points arising



from the polymerisation of Iodic acid according to the scheme:

$$HIO_3 \leftrightarrows \tfrac{1}{2}(HIO_3)_2 \leftrightarrows \tfrac{1}{3}(HIO_3)_3.$$

The detailed paper will appear elsewhere. Our thanks are due to Dr. K. N. Mathur for the construction of the magnetic balance which is of remarkable sensitivity.

M. R. NAYAR.
N. K. MUNDLE.

Lucknow University,
December 26, 1940.

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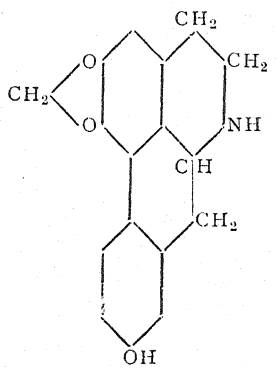
[1] *Curr. Sci.*, 1939, **8**, 73.

[2] M. R. Nayar Srivastava, Sen, Ramgopal & Sharma, *Z. anorg. u. allg. Chem.*, 1939, **240**, 217.

[3] *Phil. Mag.*, 1937, **24**, 1030.

SYNTHESIS OF *dl*, ANALOBINE-*O*-METHYL ETHER (*dl*-2, METHOXY-5, 6 METHYLENE DIOXY-NOR-APORPHINE)

ANALOBINE, an alkaloid obtained from *Asimina triloba* was assigned the following constitution by Manske[1] on the basis of analytical data:



1-2, hydroxy-5, 6-methylene dioxy noraporphine

Its synthesis was undertaken not only because it was felt that a rigid proof of its structure was desirable but also because of the great interest attached to phenolic aporphines. It was proposed to synthesise 2, benzyloxy-5, 6-methylene dioxy noraporphine, and after debenzylation resolve the inactive phenolic aporphine into the active forms. This procedure would eliminate the complications that would ensue with a free hydroxyl group at the isoquinoline ring closure stage.[2,3,4]

The starting materials were Homopiperonylamine[5] and 2, nitro-5, benzyloxy-phenyl acetic acid. The acid could not be prepared in good yield by the method of Perkin for 2, nitro-5, methoxy-phenyl acetic acid[6] because the yield of the intermediate 2, nitro-5, benzyloxy-phenyl pyruvic acid by condensation of 2, nitro-5, benzyloxy-toluene with ethyl oxalate was poor. It could, however, be prepared in good yield on the lines of the method of Gulland, Ross and Smellie[2] for 2, nitro-4, hydroxy-3, methoxy-phenyl acetic acid. *m* aldehydo-*p* nitro phenyl carbonate[7] with hippuric acid and acetic anhydride gave the azlactone (m.p. 162°) of 2, nitro-5, hydroxy-benzaldehyde. This, with alcoholic HCl under pressure at 100°, gave 2, nitro-5, hydroxy-phenyl pyruvic acid (m.p. 194°, 70 per cent.) which was then oxidised with H_2O_2 to 2, nitro-5, hydroxy-phenyl acetic acid (m.p. 199°, 90 per cent.), and benzylated to 2, nitro-5, benzyloxy-phenyl acetic acid (m.p. 165°, 80 per cent.). The acid chloride prepared by the action of thionyl chloride, on addition to homopiperonylamine gave the amide (m.p. 145°–146°) in good yield. This was converted to 2′, nitro-5′, benzyloxy-1, benzyl-3, 4-dihydro-6, 7-methylene dioxy-isoquinoline in 80 per cent. yield by PCl_5 in $CHCl_3$ at room temperature for 7 days (Picrate, m.p. 190°–191°). On reduction with Zn and HCl (d, 1·16) at 100°, the benzyloxy group was not disturbed, and 2′, amino-5′, benzyloxy-1, benzyl-1, 2, 3, 4-tetrahydro-6, 7-methylene dioxy-isoquinoline was obtained. This was extremely unstable in air. Picrate, m.p. 159°. Further work is in progress on the ring closure to the phenanthrene derivative.

Meanwhile the synthesis has been achieved of *dl*-2,methoxy-5, 6-methylene dioxy nor-aporphine starting from homopiperonylamine, and 2, nitro-5, methoxy-phenyl acetic acid. The amide (m.p. 182°–183°) was converted by PCl_5 and $CHCl_3$ at room temperature for 48 hours in 70 per cent. yield to the dihydro isoquinoline derivative (m.p. 166°–167°, Picrate m.p. 218°), and reduced to the amino tetrahydro isoquinoline derivative in 80 per cent. yield (hydrobromide, m.p. 244°). Diazotisation followed by boiling in methanol gave *dl*-2, methoxy-5, 6-methylene dioxy-nor-aporphine in 10 per cent. yield (B. hydrochloride—m.p. 305° from alcohol B.HCl. H_2O from water, m.p. 278°). It is proposed to resolve it into the active forms and compare the *l* form with Artabotrinine[7] and also Analobine O methyl ether.[1] Failing a resolution, the product obtained by a Gadamer ring cleavage on the synthetic aporphine will be compared with those obtained by a similar process on the natural alkaloids. Dr. Manske and the Institute of Medicinal Chemistry (where the late Dr. Barger worked) have been written to for specimens of the alkaloids for comparison. My grateful thanks are due to Prof. Dey for his valuable help and guidance in this investigation.

T. R. Govindachari.

Presidency College,
Madras,
January 1, 1941.

[1] *Can. J. Res.*, 1938, **16**, 76.
[2] Gulland, Ross and Smellie, *J.C.S.*, 1931, 2885.
[3] Douglas and Gulland, *ibid.*, 2893.
[4] Kondo and Ishiwata, *Ber.*, **64**, 1533.
[5] Buck and Perkin, *J.C.S.*, 1924, 1693.
[6] *J.C.S.*, 1924, 296.
[7] Mason, *J.C.S.*, 1925, 1196.
[8] Barger and Sargent, *J.C.S.*, 1939, 991.

ALLEGED DIMERIC CONSTITUTION OF ETHYLENE DIAMINO CUPRIC CHLORIDE

CUPRIC CHLORIDE is known to give with ethylene diamine three types of salts to which the formulæ Cu en cl_2, Cu en_2 Cl_2 and Cu en_3 Cl_2 are usually given. In a recent paper[1] F. N. Chattaway and H. D. K. Drew observe that the supposed ethylene diamino cupric chloride Cu en Cl_2 is in reality a dimeric substance *bis*ethylene diamino cupric cuprichloride [Cu en_2] Cu Cl_4. The proof given for the dimeric structure is that it forms, according to their observation, the copper compound [Cu en_2] Pt Cl_4 with an aqueous solution of potassium chloroplantinite. The reaction has been supposed to take place in the following manner:

$$[Cu\ en_2]Cu\ Cl_4 \xrightarrow{K_2\ Pt\ Cl_4} [Cu\ en_2]Pt\ Cl_4 + K_2\ Cu\ Cl_4$$

Grienberg previously prepared this chloroplatinite from Cu en_2 Cl_2 and potassium chloroplatinite and described it as a violet red substance. Chattaway and Drew on the other hand observe it to be lilac pink in colour. The latter investigators represent the yellow substance obtained by Grossmann by the action of hydrochloric acid on ethylene diamino cupric chloride by the formula [en H_2] Cu Cl_4. They also attribute a dimeric constitution to the isobutylene analogue of the supposed *bis*-ethylene diamino cupric cuprichloride.

The present author first tried to find out whether propylene diamino cupric chloride obtained as a greenish blue precipitate from a molecular proportion of aqueous cupric chloride dihydrate and a molecule of propylene diamine, could be given the dimeric formula [Cu pn_2] Cu Cl_4. The monohydrate (m.p. 120°) dissolved in water and with hydrochloric acid gave the double chloride Cu pn H_2 Cl_4. It did not however form the chloroplatinite [Cu pn_2] Pt Cl_4 which was readily obtained from the deep purple aqueous solution of *bis*-propylene diamino cupric chloride Cu pn_2 Cl_2 and potassium chloroplantinite. The chloroplatinite [Cu pn_2] Pt Cl_4 was lilac pink and was also easily formed by the unstable *tris*-salt evidently by its decomposition to the *bis*-salt. It was noted that with excess of Cu Cl_2, the chloroplatinite of *bis*-propylene diamino cupric chloride yielded a greenish product, apparently the same substance which was produced by the action of potassium chloroplatinite on propylene diamino cupric chloride. It was difficult to separate the green substance from solution by filtration. Whether it is propylene diamino cupric chloroplatinite [Cu pn] Pt Cl_4 or not has yet to be ascertained. It may also be mentioned that ammonium chloroplatinate which is sparingly soluble in water readily formed a violet red chloroplatinate [Cu pn_2] Pt Cl_6 both from *bis* and *tris* propylene diamine salts of cupric chloride but not from the product obtained by mixing equimolecular proportions of cupric chloride and the diamine. The lilac pink chloroplatinite and the violet red chloroplatinate are precipitated only when there is more than a molecular proportion of propylene diamine for a molecule of the copper salt. Having failed to obtain any proof of the diameric structure in case of propylene diamino cupric chloride, experiments were performed with ethylene diamino cupric chloride. But the results obtained were exactly similar to the above. The present author therefore does not think that there is sufficient reason for giving a dimeric formula to ethylene diamino cupric chloride. It may simply be represented as the mono compound Cu en Cl_2.

KANAI LAL MANDAL.

Chemical Laboratory,
Presidency College,
Calcutta,
January 11, 1941.

[1] *J. Chem. Soc.*, 1937, 947.

TWO NEW GENES FOR COROLLA COLOUR IN *CICER ARIETINUM* L.

AN extensive survey of morphological variability in *Cicer arietinum* L., has shown the occurrence of plants with various coloured petals. These are usually found to be white,

greenish-white, blue and pink.[1,2] Variations among the pink types have also been noted.[2] The genic analysis of petal colours in gram, however, has so far revealed only the presence of four genes, W, B, P and C.[3,4,5] According to Ayyar and Balsubramaniam,[5] the genes B and C are complementary and produce blue colour in petals. In the presence of C, the gene P converts blue to pink, thus it is considered as a supplementary gene. White petals result in the absence of any one of the three genes either alone or in combination except when B and C are together. The gene W suppresses greenness changing greenish-white standard to white. Its relation to other genes is not known.[3]

While working for the genetic improvement of gram in Bombay the writers have found in local material pink and white flowered plants. So far neither local nor hybridized material in gram with us has shown the presence of blue-flowered plants. We have, however, found two distinctly new petal colour types which do not seem to have been reported so far. One of them has light salmon coloured petals and is easily distinguishable from the normal pink type. This type originates from a solitary plant discovered in a field of local gram at the Cereal Breeding Station, Niphad, in the year 1932. The other type has very light purplish petals but dark purple veins. This was discovered in a local sample obtained from Chikodi, Belgaum District, and grown at Niphad in the season of 1936.

Crosses of the salmon type with a normal pink type, showed the dominance of the latter in the F_1 and a monogenic segregation in the F_2 (57 pink : 19 salmon). When crossed with a white-grained and white-flowered type the F_1 showed pink flowers, and in F_2 a ratio of 9 pink : 3 salmon : 4 white flowers (actual numbers 45 : 13 : 19) was obtained. The F_3 confirmed the F_2 behaviour. We may, therefore, consider the salmon type to be due to a distinct gene. We propose to designate this gene as Sa.

Only one cross involving the purple-veined type is available. This consists of a white-flowered and yellow grained type. The F_1 was purple-veined and in F_2 a monogenic ratio of the two colours (actual numbers 34 and 15) was obtained. Its relation with other types is under investigation but it may be concluded that the purple-veined flowers are caused by a distinct gene, which we have designated as Pu.

B. S. KADAM.
S. M. PATEL.
V. K. PATANKAR.

Cereal Breeding Station,
Kundewadi, Niphad, Bombay,
January 21, 1941.

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[1] Howard, A. G., Howard, L. C., and Khan, A. R. *Mem. Dept. Agri. India Bot. Ser.*, 1915, **7.**

[2] Shaw, F. J. F., and Khan, A. R., *ibid*, 1931, **19.**

[3] Khan, A. R., and Akhtar, A. R., *Agric. and Live-Stock in India*, 1934, **4.**

[4] Singh, H., and Ekbote, R. B., *Ind. Journ. Agric. Sc.*, 1936, **6.**

[5] Ayyar, V. R., and Balsubramaniam, R., *Proc. Indian Academy of Sciences*, Sec. B, 1936, **4.**

ADVENTITIOUS ROOTS OF RAGI (*ELEUSINE CORACANA*, GAERTN.)

IT is a well-known fact that in all grasses there is a ring of root-meristem at the base of each node. From this region the roots are induced to grow and function as normal ones whenever the nodes come in contact with the humid soil. The stems when broken can establish themselves as new plants. This capacity to form the roots at the nodes may be considered as one of the chief causes for the rapid multiplication and spread of the grasses and also the dominant position they occupy to-day in the plant kingdom.

This quality has been since very early times made use of in the propagation of some of the cultivated grasses as sugarcane. In the cultivated sorghums also, the adventitious roots are developed to a greater or smaller extent in all the nodes (Ayyangar, G. N. R., and Rao, V. P.[1]). New plants of sorghum have been successfully raised by setts as in the case of sugarcane (Thomas, R., and Venkataraman, T. S.,[2]

Rea, H. E., and Karper, R. E.[3]). The latter authors found that in the Maize (Mosshart Yellow Dent Corn) no new plants could be obtained since only root growth was induced and no shoot growth. Recently a sample of cuttings of stems (without roots) of *Echinochloa colona* var. *frumentacea* was received at the Millets Breeding Station. These cuttings when planted in pots struck roots easily and developed into well-grown plants.

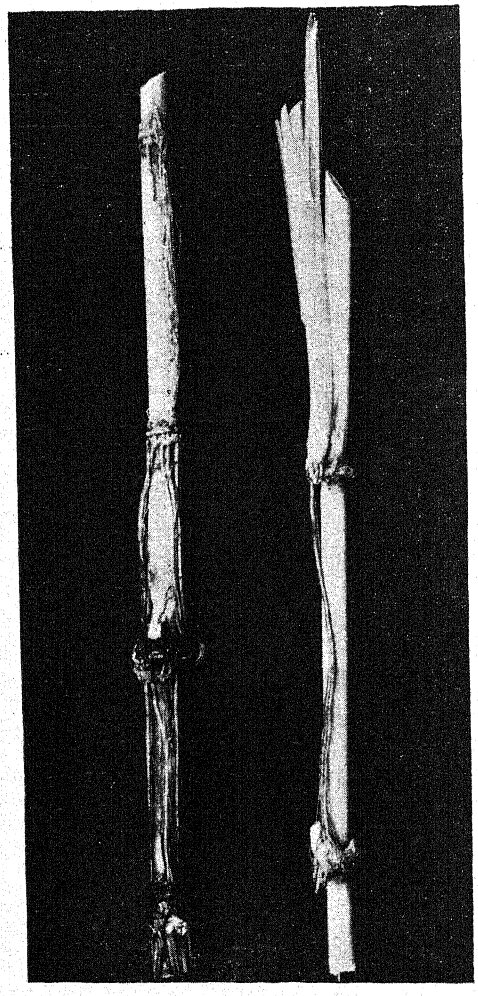


FIG. 1. (*a*) Internodes showing roots at nodes; (*b*) axillary bud from upper node, with long roots. Usually the axillary bud grows into a branch without roots

In Ragi the development of the adventitious roots in the upper nodes is not found, though they develop occasionally when the nodes come in contact with wet soil. In some of the plants from X-rayed seeds grown in 1940, it was noted that profuse, long, thin, wiry roots had developed in almost every node (Fig. 1). The internodes usually remain enclosed in the leaf sheath and therefore the roots grow along the internodes closely adpressed to it, till they reach the lower node. Here their further elongation is obstructed by the leaf sheath base. They therefore tend to grow round the stems and encircle it. Most often the roots become much branched and a mat of roots just above the node results. There is good development of root hairs at the root tips. Ragi is an annual plant. Its capacity to form the adventitious roots therefore presents a possibility of propagating desirable plants which would otherwise be lost through seed formation or in the multiplication of rare hybrids and thus obtain a greater quantity of seeds.

N. KRISHNASWAMY.
G. N. RANGASWAMY AYYANGAR.
Millets Breeding Station,
Coimbatore,
January 22, 1941.

[1] *Curr. Sci.*, 1935, **3**, 485.
[2] *Agric. Jour. India.*, 1930, **25**, 164.
[3] *Amer. Jour. Bot.*, 1932, **19**, 464.

THE INHERITANCE OF THE MANIFESTATION OF PURPLE COLOUR AT THE PULVINAR REGIONS IN THE PANICLES OF SORGHUM

ANTHOCYANIC purple pigmentation manifests itself in various parts of the sorghum plant and in various stages of its growth. The existing knowledge on this subject has been summarised recently.[1] When the shoot (coleoptile) is coloured purple (gene PC), the axil of the leaf-sheath is also coloured purple. When the shoot is deep purple, the axil is coloured deep purple and in addition to this the auricular junction (gene PJ), the outer margins of the leaf-sheath and the nodal band are also coloured purple. When the auricular junction is coloured purple, the anther may or may not be coloured purple; but when the anther is

coloured purple, the auricular junction is always coloured purple.[2]

In the panicle, there are usually specialised cushiony tissues called the pulvinii, at the place of insertion of the branches into the main stalk of the branchlets into the branches, and of the pedicels of spikelets into the branchlets. These help in the movement of the branches of the panicle exposed to high winds. These panicular pulvinii are homologous to the auricular junctions. When the leaves are non-auriculate, the panicles lack the pulvinii, and the panicle branches are adpressed to the main stalk.[3]

Among the rare places at which purple pigment may manifest itself are the anther sacs and the pulvinii in the panicle. Purple coloured anthers and pulvinii are rare in sorghum. They go with a deep purple coleoptile, which character is African in origin. A deep purple coleoptile goes with a purple coloured auricular junction, which latter character is also African in origin. So is the anther purple character.

It has been noticed that when the anther is coloured purple, the pulvinus in the panicle is always coloured purple. Plants with purple coloured pulvinii may rarely have the anther of their flowers non-purple coloured. Similarly though the auricular junction be purple coloured, the panicular pulvinus may be non-purple coloured.

In the following table are given the cultivated sorghum varieties, having purple coloured pulvinii, picked out from the world collection at the Millets Breeding Station, Coimbatore.

M.B.S. Selection Number	Botanical Name	African Name	Source in Africa	Colour of		
				Auricular junction	Panicular pulvinus	Fresh anther-sac
A.S. 3947	*Sorghum Roxburghii*	Gebere	Tanganyika	Purple	Purple	Purple
A.S. 3981	*S. elegans*	Chamzingo	,,	,,	,,	,,
A.S. 4575	,,	Mdula	,,	,,	,,	,,
A.S. 4590	,,	Kitembo	,,	,,	,,	Light Purple
A.S. 4378	*S. coriaceum*	Meelepu	North Rhodesia	,,	,,	Purple
A.S. 4592	*S. nigricans*	Chamzingo	Tanganyika	,,	,,	Light Purple
A.S. 4660	,,	Kikuma	,,	,,	,,	Purple
A.S. 4661	,,	,,	,,	,,	,,	,,
A.S. 4662	,,	,,	,,	,,	,,	,,
A.S. 4537	*S. caudatum*	Dakkata	Nigeria	,,	,,	Light Purple
A.S. 4547	,,	Jardiya	,,	,,	,,	Yellow

In the wild sorghums it is interesting to note that this character is found in four species—*S. versicolor, S. purpureosericeum, S. dimidiatum* and *S. halepense*—all of which are African in origin. Hence it may safely be concluded that this rare character is African in origin, most of the cultivated types having it, coming from the Tanganyika territory.

The purple colour appears at the pulvinar regions of the panicle just before the plant begins to flower. The cushiony tissue at these regions develops purple spots to begin with and then turns completely purple, as the flowering progresses. When the flowering is complete, the purple colour begins to fade, and disappears in two or three days. The best manifestation is at the flowering stage.

To examine the inheritance of this character

in its simple manifestation, a cross was made between the two following parents:—

Selection Number	Auricular junction	Colour of panicular pulvinus	Fresh auther-sac
♀ A.S. 4547	Purple	Purple	Yellow
♂ A.S. 4554	,,	No-Purple	,,
F_1 ..	,,	Purple	,,

The F_2 gave a simple monohybrid segregation, the numbers being 184 plants with purple and 57 with colourless pulvinii. In the F_3, of the four families raised, one was pure for purple pulvinii, and three segregated as in the F_2, the total of the three families being 173 purple and 60 colourless pulvinii. This capacity to take on anthocyanic purple pigmentation in panicular pulvinii, is thus a monogenic dominant.

In the above cross the parents differed also in the juiciness of their stalks, and cross collations gave pithy-coloured, pithy-colourless, and juicy-coloured and juicy-colourless plants in the ratio of 174, 58, 62 and 15, indicating that this character (gene D)[4] is independent of the character inducing the manifestation of purple pigment in panicular pulvinii.

It will thus be seen that anthocyanic purple pigment occurs in such obscure parts as panicular pulvinii, in certain rare types of African sorghum, mostly from the Tanganyika territory. This character is a monogenic dominant to its absence, and forms part of a chain of manifestation in which the auricular junction and the anther participate.

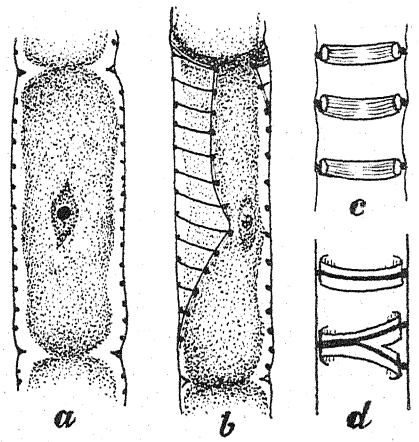
G. N. Rangaswami Ayyangar.
A. Kunhi Koran Nambiar.
Millets Breeding Station,
Coimbatore,
January 22, 1941.

[1] *Jour. Madras University*, 1938, **2**, 131.
[2] *Proc. Ind. Acad. Sci.*, 1938, **8**, 318.
[3] *Ibid.*, 1938, **6**, 286.
[4] *Madras Agrl. Jour.*, 1937, **5**, 157.

THE ORIGIN AND NATURE OF THE *BASES* OF THE SECONDARY THICKENINGS OF XYLEM VESSELS IN *HERACLEUM SPHONDYLIUM* L.

Rothert[1] was the first to point out that the secondary thickenings (bands) of xylem vessels are not inserted *directly* on the primary walls, but are attached to the latter by *bases*. According to him these are formed ontogenetically by the contraction of the dorsal side of the bands themselves.

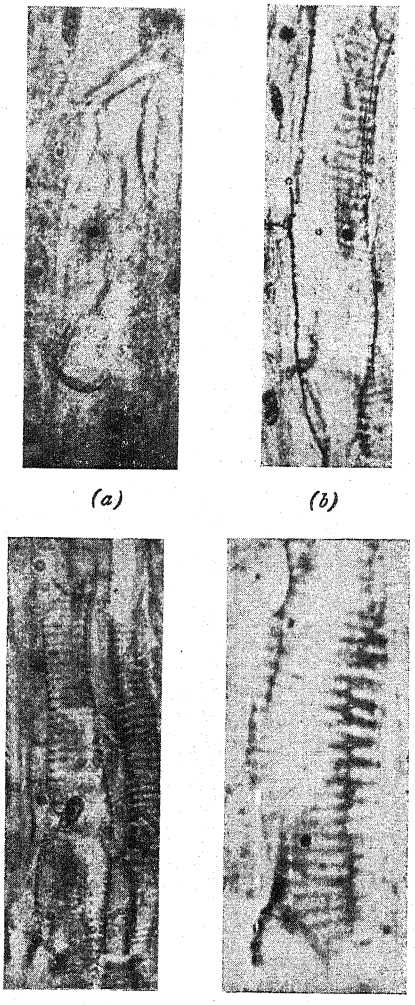
The developmental studies in *Heracleum* show that the origin of these bases is independent of the bands. When the vessel segments, during their differentiation, have attained their fullest expansion the bases are deposited as localised thickenings on the inner



(Semi-diagrammatic) vessel segments showing different stages in the development of a *base*: *a*, base in cross section on primary wall; *b*, part of the primary wall and bases in surface view; *c*, primary wall, bases and their bands in l. s. of the vessel segment; *d*, base and its band in surface view.

surface of their primary longitudinal walls in the pattern of the bands to be deposited soon after. Their chemical nature appears to be the same as that of the primary wall as they stain equally deeply with fast green. In cross-section these local thickenings appear as fine dots (Fig. 1 *a*, *b*). Microchemical and other tests show that they are more pectin than cellulose.

These localised thickenings of the primary wall ultimately form slight projections into the cavity of the vessel segments, and



(a) (b) (c) (d)

FIG. 2

Photomicrographs of stages shown diagrammatically in Fig. 1 *a*, *b*, *c*, & *d*, respectively.

these projections secondary layers are subsequently laid down by the protoplasts (Fig. 1 *c*, *d*). When lignification of the bands has proceeded for some time and the colour reaction with safranin is rather light or faint these projections stained with fast green appear as bright green lines running through the centre of each band across the wall of the vessel (Figs. 1 *d*). In strongly lignified bands the bases can no longer be distinguished by colour reaction.

Thus the *base* in *Heracleum* is different from its band both in origin and in chemical nature. It is not an integral part of the band and is not formed by the contraction of the base as Rothert believed. Neither Barkley,[2] Esau,[3] nor Murray Scott[4] noticed any contraction of the bars once they were formed, during or prior to lignification. Haberlandt[5] describes some plants in which the insertion of the fibres (bands) is never seen to be contracted at all.

G. P. MAJUMDAR.

Botanical Laboratories,
Presidency College, Calcutta,
December 11, 1940.

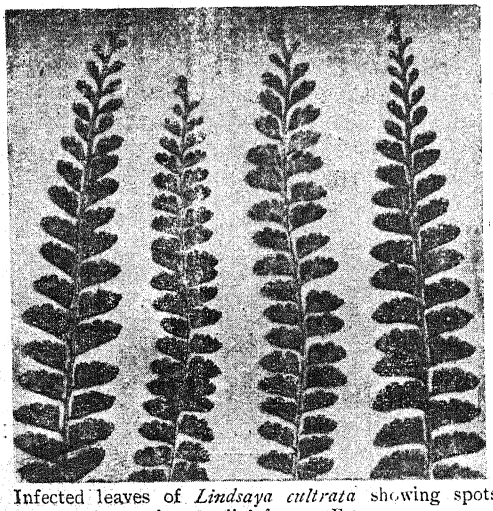
[1] Rothert, *Bull. Akad. Crac.*, 1899, cited in 3.
[2] G. Barkley, *Bot. Gaz.*, 1927, **83**, 173.
[3] K. Esau, *Hilgardia*, 1936, **10**, 431.
[4] Murray Scott, *Madrono*, 1933, **3**, 190.
[5] G. Haberlandt, *Physiol. Plant Anat.*, Eng. ed., 1914.

A MYCELIAL FUNGUS ON LIVING LEAVES OF *LINDSAYA CULTRATA*

ONLY a few fungi are known to occur on ferns but none seem to have been recorded on *Lindsaya cultrata* of the Polypodiaceæ (*cf.* Oudemans,[1] Verdoorn[2] and Saccardo[3]). The writer has observed a large number of living fronds of this fern to be heavily infected by a mycelial fungus at Ghoom in the district of Darjeeling, Bengal, in the month of September. The infected plants were growing in shady moist places.

Externally very slightly raised blackish spots are found at the margin of the leaflets on their lower surface as can be seen in the accompanying photograph. There are many minute nearly circular spots in a single leaflet but a number of them may coalesce to form large irregular black patches up to 5 mm. in length. On the upper surface smaller black dots are seen at places corresponding in position to the infected areas on the lower side. A large number of specimens have been examined but no spores of any kind could be found. The mycelium is branched, septate and dark brown in colour. It ramifies freely in the intercellular spaces of the infected region of the leaf but does not send haustoria into the cells. Many hyphæ are found collected in the sub-stomatal spaces. Some of them come out through the stoma and form

a sort of compact, dark brown to black, circular stroma outside, thus blocking the pore. A large number of stomata are found to be blocked by these stromata.



Infected leaves of *Lindsaya cultrata* showing spots due to the mycelial fungus *Ectrostoma*

No spores of any kind could be found. So the fungus may be provisionally placed in the group *Mycelia sterilia* of the *Fungi imperfecti*. As it is maculiform and produces black stromata on the leaves it is probably some species of *Ectostroma*. A fuller description of this fungus together with its specific determination will appear elsewhere.

A. K. Mitra.

Department of Botany,
University of Allahabad,
January 2, 1941.

[1] Oudemans, C. A. J. A., *Enumeratio Systematica Fungorum*, 1924.
[2] Verdoorn, Fr., *Manual of Pteridology*, 1938.
[3] Saccardo, P. A., *Sylloge Fungorum*.

THE FUNCTION OF PROTOZOA IN THE ACTIVATED SLUDGE PROCESS

It is now generally recognised that the occurrence of certain forms of protozoa in the activated sludge tank is closely associated with the efficiency of the process of purification. It has also been conversely observed that, as the protozoa either diminish in numbers or occur encysted due to deficiency of aeration or other unfavourable conditions, sludge formation is poor and the resulting effluent unsatisfactory. Richards and Sawyer[1] reported that, in so far as the protozoa kept down the bacterial numbers they might be regarded as detrimental to the purification. They found, however, that the increase in bacterial numbers following suppression of protozoa by partial sterilization produced no improvement in the purification of sewage; on the contrary, both carbon and nitrogen 'fermentations' were seriously retarded. Furthermore, there was a change in bacterial flora, nitrifying organisms being suppressed by the treatment. Cramer[2] observed that, after reaching a certain stage of development, the protozoa die and disintegrate thus affording food for bacteria.

With a view to obtaining some direct information regarding the part played by protozoa, both singly and collectively, in activated sludge, a series of experiments were carried out isolating several prominent strains and by inoculating them in different ways into experimental bottles containing equal quantities (1½ litres) of sterile raw sewage (prepared according to Butterfield *et al*[3]) and bubbling air through them. These included four forms of protozoa and thirteen species of aerobic bacteria. The quantities of inocula were adjusted in each case to correspond to the numbers actually present under tank conditions. The extent of sludge formation and the composition of the effluent were determined in each case at frequent intervals.

It was observed that although all the bacteria that were tried showed some sludge-forming properties, the protozoa with the associated bacteria were much more efficient. They also produced clearer and cleaner effluents. None of the bacteria yielded more than 0·4 to 0·5 per cent. of sludge; the corresponding effluents were invariably turbid. Among the protozoa, the *Vorticella* were the most efficient: they not only yielded the highest percentage of sludge (2·5 per cent.) but also gave the cleanest effluent.

The foregoing observations, though essentially of a preliminary character, yet serve to bring out the importance of protozoa in sludge formation. By forming slimy aggregates with

high adsorptive power they help to collect the major part of the colloidal matter of the sewage. The vigorous flow of diffused air keeps the resulting sludge well dispersed in the form of granules and thus facilitates its interaction with the incoming raw sewage.

Further work is in progress with special reference to the relation of protozoa to nitrification and other oxidation changes in the activated sludge tank.

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Department of Biochemistry,
Indian Institute of Science,
Bangalore,
January 6, 1941.

[1] Richards, E. H., and Sawyer, G. C., *J. Soc. Chem. Ind.*, 1922, **41**, 62T.
[2] Cramer. R., *Ind. and Eng. Chem.*, 1931, **23**, 309.
[3] Butterfield, C. T., *et al.*, *U. S. Treasury Dept. Public Health Reports*, 1937, **52**, 387.

A NEW ASPECT OF HYDROPONICS : "HANGING GARDENS" IN THE ACTIVATED SLUDGE TANK

THE art of farming without soil has recently awakened considerable public interest. By employing the familiar method of 'water cultures' a great deal of work has been carried out during the last two years particularly in California[1] and in England.[2]

The conditions obtaining in the aeration tanks of the activated sludge installation, the presence of practically all the elements of plant nutrition as also plenty of air, would show that it is suited to setting up what may be termed "Hanging Gardens". Suitable trays made of wood or tin or any other material which is not likely to be attacked by the liquid in the tank or the gases evolved therefrom may be used for growing the plants. Trays of convenient sizes, provided with strong open wire mesh bottom and filled with pebbles graded up to fine soil at the top or some fibrous material like *coir* fibre, would be suitable for the purpose; straw may also be used as bedding for the growing plants. Such boxes or trays with the desired plants may be hung, properly supported, in the aeration chambers of the tank so that the tank liquid reaches only up to the top of the pebbles or the bottom layer of the fibrous material, as the case may be. Provision may also be made for the boxes to float and maintain their position on the surface of the aeration tanks and adjust themselves with the rise and fall of the liquid, by having sealed tins filled with air attached to the bottom of the boxes.

At the suggestion of Dr. Gilbert J. Fowler, a systematic investigation into the possibilities of growing the various food plants and flower plants in the activated sludge tank at the Indian Institute of Science was undertaken. The growth of rice, ragi, tomatoes, chillies, roses, tuberoses and marygold by the system of "Hanging Gardens" has been studied and, in certain cases, highly promising results have been obtained. The plants showed highly luxuriant growth and were, in fact, almost giant specimens. Tillering and ear bearing in the case of rice and ragi were indeed phenomenal. Most of the rice plants put forth more than 50 tillers.

Work is being extended to other crops and flowering plants. It would appear that apart from the possible utilisation of the activated sludge process, especially large works, for agricultural and horticultural purposes, the system of "Hanging Gardens" will also prove an elegant technique for studying some of the fundamental problems of plant nutrition, more especially the nature of the microflora and fauna under the conditions of plant growth, since the microbiological changes which proceed in the activated sludge tank are essentially the same as those in the soil.

S. C. PILLAI.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
January 6, 1941.

[1] Gericke, W. F., *Nature*, 1938, **141**, 536; —, 'The Complete Guide to Soilless Gardening'. (Putnam & Co., Ltd., London, 1940.)
[2] Cheshnut Experimental Station *Ann. Rep.*, 1939, p. 13; Millard and Stoughton, *Sci. Hort.*, 1939, **7**, 174; Templeman and Watson, *J. Min. Agric.*, 1938–39, **45**, 771; Hilver, C. I., Hydroponics : Food without Soil ; a Journal of Experiments, 1938–1940, p. 116. Pelican Special S 63 published by Penguin Books Ltd.
Russell, E. J., *Nature*, 1940, **146**, 448.

SOIL ALGAE OF LAHORE

DR. JAGJIWAN SINGH has published a short note on the above subject in the January 1941 issue of the *Current Science*. The justification for publishing such a note is his supposed new record of three genera not previously recorded from soil. These are *Pandorina*, *Trachelomonas* and *Phacotus*. Sandon, from Rothamsted Microbiology Department, in his book on "Composition and Distribution of Protozoan Fauna of the Soil", has noted *Pandorina morum* and *Trachelomonas volvocina* as regular soil forms. The former is widely distributed and has been recorded by Sandon from various countries including India. *Trachelomonas* has also been recorded from this country. Regarding identification of *Phacotus* from the soil, it seems that the author has confused it with *Chlamydomonas*, one of the commonest soil forms. The undersigned has seen his drawings, but there was no *Phacotus*.

A comprehensive list of algal flora of the Lahore soils has been published from this laboratory by Hardyal Singh[1] and a list of soil flagellates and ciliates occurring on Indian soils from twenty-four different parts of the country has been published by the undersigned.[2]

H. CHAUDHURI.

Department of Botany,
Panjab University, Lahore,
January 31, 1941.

[1] *J. Ind. Bot. Soc.*, 1933, **12**, 102.

[2] *Annales de Protistologie*, 1929, **2**, Fasc. I, Vol. II, pp. 41–60.

INDUSTRIAL RESEARCH UTILISATION COMMITTEE

THE formation of the utilisation committee by the Government of India, to assess the commercial worthiness of completed pieces of industrial research, constitutes a welcome and praiseworthy step which must assure the public of the intensely practical and business-like manner in which the Board of Scientific and Industrial Research is conducting its work.

Valuable results from research schemes instituted at the instance of the Board of Scientific and Industrial Research or conducted at the Central Government's Laboratories at Alipore, Calcutta, have already been achieved and the possibility of their industrial utilisation proved to the satisfaction of the Board. The time has now come to decide on how best these results can be utilised in practice. The Government of India have come to the conclusion that they should take the advice in this connection of a Committee of non-officials to be called the Industrial Research Utilisation Committee. The Committee, will be presided over by the Hon. Diwan Bahadur Sir A. Ramaswami Mudaliar, Member of the Governor-General's Executive Council in charge of the Departments of Commerce and Labour. Its members will be: Sir Shri Ram, New Delhi; Sir Ardeshir Dalal, Bombay; Sir Homi Mody, Bombay; Sir Sultan Ahmad, Patna; Mr. Kasturbhai Lalbhai, Ahmedabad; Mr. P. F. S. Warren, Calcutta; Dr. Narendra Nath Law, Calcutta; the Hon'ble Mr. J. H. S. Richardson, Calcutta; Sir Frederick James, Madras; Sir Rahimtoola Chinoy, Bombay; Sir Jwala Prasad Srivastava, Cawnpore; Khan Bahadur Sir Saiyed Maratab Ali Shah, Lahore; Sir Abdul Halim Ghuznavi, Calcutta; Diwan Bahadur C. S. Ratnasabhapathy Mudaliar, Coimbatore; Mr. Nalini Ranjan Sarkar, Calcutta; Mr. F. Stones, Bombay and Dr. Sir Santi Swarup Bhatnagar, Director of Scientific and Industrial Research, Calcutta, co-opted as a member. Mr. T. S. Pillai, General Secretary of the Board of Scientific and Industrial Research, will be the Secretary.

The functions of the Committee will be to advise the Central Government on: (1) the selection of the particular industrial concern or concerns to which the results of research schemes should be made available for utilisation; (2) the terms and conditions, including the question of payment for royalties, etc., on which this can be done; (3) the question of the division of the royalties on patent rights, which will vest in the Central Government on the one hand, and, on the other, the Provincial Governments, institutions, and scientists responsible for the research, and as among the scientists themselves; and (4) generally the best methods whereby the industrial development of the research can be undertaken and an equitable arrangement made for securing that the services of the scientists concerned are adequately rewarded. The Central Government will be the final authority to decide how the results of research schemes placed before the Industrial Research Utilisation Committee will be utilised and by whom, and on all other matters on which the advice of the Committee is sought.

REVIEWS

General Physics for Students of Science. By Robert Bruce Lindsay. (John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London), 1940. Pp. 554. Price 22*sh.* 6*d.*

It is difficult to write a book purporting to cover the whole of physics, aiming at a fairly high standard, within the limits of a single volume, when advance in every branch is both rapid and profound. In fact the tendency is to devote books to particular branches of physics.

The present book is an attempt to cover in a single volume of 554 pages the whole range of physics, including some of the more recent developments. The standard aimed at can be gauged from the fact that simple calculus methods are freely employed and a small attempt is made to introduce vector methods in certain parts. The subject-matter is divided into five parts comprising 29 chapters.

The first part, chapters 1 to 3, gives a general introduction, dealing with scientific method, a historical review of the progress of physics from Aristotle to the present day and a short exposition of the general properties of matter. Part two is devoted to mechanics, dealing with general dynamics, oscillatory motion, work and energy, gravitation and planetary motion, systems of particles, motion of a rigid body, statics, elasticity and some properties of liquids, in succession. The five chapters of part three are given to heat, including a short treatment of the kinetic theory and thermodynamics. Magnetism and electricity are comprised in part four, wherein alternating current circuits, and electrical discharge through gases are included. Part five, styled Radiation, deals in succession with sound, geometrical and physical optics, thermal and spectral radiation, with a short excursion into atomic structure.

It will thus be seen that an attempt is made to traverse the most important fields in physics in a comparatively short compass. The treatment is naturally not detailed or intensive, though a clear exposition of such topics as are taken up is attempted. Lack of adequate space limits the scope of such attempts. As a text-book for students of other sciences to obtain an insight into the domain of physics, the book will be very useful. But for those who specialise in physics to the standard attempted in the book—which may be taken as the B.Sc. standard—the book may fall short of their needs.

Each chapter is followed by a good selection of examples illustrative of the principles embodied in the chapter.

Errors are few, but we may point out on page 81 the definition of an erg as the energy of 1 gm. moving at 1 cm. per second.

A. V. T.

Electrical Measurements in Principle and Practice. By H. Cobden Turner and E. H. W. Banner. (Chapman & Hall, Ltd., London). Pp. 354. Figs. 219. Price 7*sh.* 6*d.*

This is a cheaper edition of the book which was first published in 1935. It meets the long-felt want for a book dealing with the general description and working of the various types of measuring instruments that any electrical engineer may come across. The list of instruments described is almost exhaustive and the treatment clear and simple. The use of mathematics with which many operating engineers feel rather uneasy, has been avoided. The technical terms, symbols and abbreviations employed are in accordance with the recommendations of the British Standards Institution.

The book is divided into five parts. The first part consists of three chapters dealing with units and standards, the second part is divided into nine chapters giving general descriptions of almost all the different types of electrical measuring instruments met with in practice. Parts III and IV consist of three and five chapters respectively dealing with electrical measurements. The last part which consists of four chapters covers indirect electrical measurements some of which such as the 'dryness of timber' and 'acidity of fruits' are interesting.

The authors might consider the following suggestions before the publication of the next edition:

(1) More adequate treatment of the testing of Energy Meters and Instrument Transformers.

(2) The addition of a chapter on high voltage tests on insulators and insulating materials.

The book is abundantly illustrated. A

glossary of technical terms and a few charts indicating at a glance the scope and range of the various measuring instruments employed are other desirable features. The get-up of the book is good and its low price of 7*sh.* 6*d.* brings it within reach of almost everyone. K. ASTON.

Television: The Electronics of Image Transmission. By V. K. Zworykin and G. A. Morton. (Chapman & Hall, Ltd., London), 1940. Pp. 646. Price 36*sh.*

This book on the electronic aspect of television by two of the foremost workers in the field, supplies to the radio engineer and experimenter a long-felt need for an authoritative work on the subject. So far as the reviewer is aware, this is the first book on the electronics of television meriting the name of a reference book which brings together the more relevant parts of the numerous technical papers that have appeared during recent years.

The book opens with a brief historic survey of the discovery of electrons and the photoelectric effect leading on to the discussion of such phenomena as the photoelectric and thermionic emission of electrons, the mechanism of luminescence and certain aspects of electron optics, and several other physical principles that provide a useful background for the proper understanding of the subject. The second part deals with the general principles of television and gives a fairly clear conception of the factors contributing to the quality of pictures in relation to the various physical methods employed. Such items as synchronization, scanning, amplifiers, and certain aspects of high frequency transmission and reception of television signals, are all dwelt upon. What is probably most interesting from a practical point of view is the section dealing with the various component parts and electronic devices employed in television; like iconoscopes, kinescopes, electron guns, etc., and their methods of construction. Sufficient practical details are included to enable one to construct some of these devices in the laboratory. This feature in conjunction with a very detailed account of a model television receiver (a circuit diagram of which is given with the values of the component parts) should prove to be valuable to those entering this interesting field.

What would appear as a discontinuity of subject-matter in the chapters of the main text is partly made up towards the end, by a detailed description of the sequence of working of a typical television equipment at RCA and NBC installations.

The concluding part of the book deals with the nature of certain television problems and the future of television, and gives an extremely practical view-point of the television art, and its future, as gauged from its present stage of development, by one whose contributions to the subject are so well known.

The book is profusely illustrated with neat diagrams and leaves nothing to be desired in the nature of artistic get up. The bibliography at the conclusion of each chapter should prove very useful and will be appreciated by those who need original references. The book should prove of great value to the engineer, the experimenter and to all those interested in the subject, and should find a prominent place in every technical library. C. C.

Intermediate Practical Physics. By T. M. Yarwood. (MacMillan & Co., London), 1940. Pp. 307 + xii. Price 6*sh.*

The book is well written, describing 106 different experiments ranging over the whole course in Physics. Each experiment begins with a statement of the apparatus required, followed by a brief description of procedure. The formulæ required are written out and figures and diagrams given showing the apparatus, its disposition and working whereever necessary. Tabular statements and graphical methods of studying results are provided. Thus the description, though generally brief, is precise and helpful.

The first chapter is devoted to general instructions dealing with procedure, errors of observation, limits of accuracy, methods of calculation and graphical work. Ten pages towards the end contain some 20 tables of useful physical data, and these are followed by four-figure tables of logs, antilogs, sines, cosines and tangents.

Several of the experiments are probably outside the normal routine of the Intermediate courses of most Indian universities, though these differ in their standards in individual subjects, depending on the number of subjects taught, the attention devoted to languages and the number of hours assigned to practical work per week. Thus, experiments on Young's modulus, surface tension, viscosity, Clement and Desorme's experiment, fourth power law of radiation,

Newton's rings, Lloyd's mirror, Kundt's tube, magnetisation curves, earth inductor and capacities of condensers, to mention a few, are likely to lie beyond the scope of the syllabus, practical or theoretical, of Intermediate courses in most Indian universities. However, it is possible to make a judicious selection of experiments to suit any Intermediate course, from those given in the book. A. V. T.

Plant Viruses and Virus Diseases. By F. C. Bawden. (Chronica Botanica Co., Leiden-Holland), 1939. Pp. 272. Price 7 guilders.

Although virus diseases of animals and plants were recognised since the middle of the last century, the nature of their causal entity remained obscure for a considerable time. The study of viruses was rendered difficult by the fact that their isolation and culture could not be achieved by the orthodox methods practised by bacteriologists and mycologists. The early investigations in the field of virus diseases were mainly directed towards the elucidation of symptomatology, mode of artificial and natural transmissions, relationships between viruses and their vectors, range of host-plants, and the nature of immunity in hosts.

With the discovery of Stanley in 1935, that the tobacco mosaic virus could be obtained in a state of crystallinity, a new era of spectacular progress in this field was ushered in. A wide circle of scientific investigators immediately got themselves interested in a field of research, till then considered purely biological and obscure. Bawden and Pirie were the first to establish the nucleoprotein character of the mosaic virus. Chemists, crystallographers, serologists, physicists, and others have interested themselves in a fascinating study of these intriguing pathogens, many of which could be obtained in a state of perfect crystallinity. Their intensive labours have resulted in the accumulation of a large volume of significant data. Bawden's contributions in this field have been both intensive and substantial. There was the imperative need to correlate and critically appraise these data. The appearance of the volume on this subject is therefore timely and appropriate. It would be difficult to find an equal more competent to handle the subject with the critical thoroughness, logic and clarity which distinguish the entire volume. By producing this classic, the author has placed a wide circle of investigators in this field under a deep debt of gratitude. M. S.

Annual Review of Physiology, Vol. II. By James Murray Luck and Victor E. Hall. (American Physiological Society and Annual Reviews Inc.), 1940. Pp. vii + 501. Price $5·00.

The second volume of this new series of Annual Reviews has appeared in spite of the terrible distractions of war confronting the world; the direct result of this unhappy state is reflected in the fact that there are no contributions from Europe which is the scene of the crisis. It is indeed creditable and flattering to the American continent that, in spite of this unavoidable exclusion of European physiologists, a comprehensive review on the most important topics of physiological research has been presented in this volume.

Twenty reviews comprising the volume cover the field of the physiology of tissues and tissue fluids like, the blood and the lymph. Important systems and processes which are fundamental to life, like respiration, the heart, the central nervous system, the autonomous nervous system, reproductive organs, the digestive system, have been individually treated; progress in the field of the special senses and the endocrine glands are covered by two separate reviews.

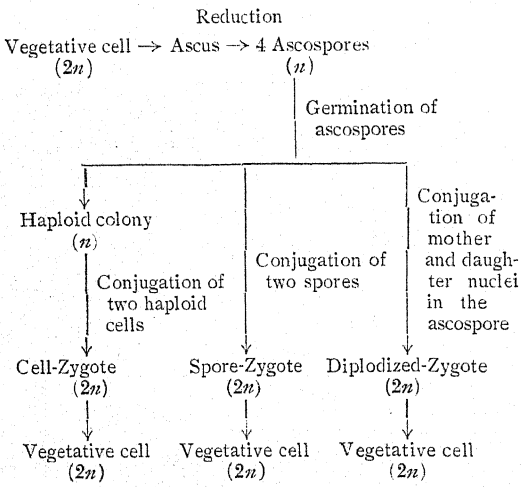
Of special interest to organic chemists and pharmacologists are the two chapters on the pharmacology of barbiturates and arsenicals. The review on the defense mechanisms in infectious and related diseases is very stimulating while that devoted to exercise has a public appeal in a country where national fitness has long been neglected. The part which physiological researches could play in the removal of "physical illiteracy" and the attainment of National Fitness and efficiency, is revealed in this chapter. Attention should be invited to the chapter on physiological psychology which contains a useful summary of the researches carried out in this field, particularly the influence of harmones and vitamins on the emotional and intellectual qualities of the animal.

Like its companion series, the Annual Reviews of Physiology will render themselves indispensable to all chemists, physiologists, psychologists and to the progressive man of medicine. M. S.

THE CYTOLOGY AND GENETICS OF YEASTS

IN 1935 Prof. O. Winge announced his pioneering researches[1] on the artificial hybridisation of yeasts. Five papers[2,3,4,5,6] which have since appeared from his laboratories constitute a valuable series of researches on the genetics of yeasts. More than a dozen yeast hybrids, one of them possessing remarkable characteristics of value to the brewing industry, have been evolved by Prof. Winge.

It was generally believed that the vegetative phase in the life-cycle of yeasts was haploid and that the ascospores in the saccharomycetes were parthenogenetically formed. By adopting an elegant microtechnique, Prof. Winge isolated and cultured individually under the microscope, all the four ascospores of an ascus. This technique facilitated the observation of all the cells of a microcolony. As a result of his studies, Prof. Winge showed that the life-cycle among saccharomycetes may be represented schematically as follows[1,2]:—



The one significant fact which emerges out of this work is that in the genus saccharomycetes, the cells are continuously diploid in the vegetative phase; there is a definite alteration of haploid and diploid generations in the life-cycle. Further, the ascospores germinate and produce the next generation of vegetative cells in any one of the following three ways: (*a*) The ascospores germinate to produce a haploid colony of limited size whose cells are characteristically round and non-sporulating on plaster block directly on transference. The cells of this colony conjugate to give multiple cell-zygotes which, on germination, give rise to the diploid cells, characteristically elongated, distally budding and chain forming and directly sporulating on plaster block. It is evident that the isolation and germination the cell-zygote produced as a result of cell fusion in the haploid colony, gives a completely homozygous yeast. It is also evident that the fusing cells in the haploid colony are not distinguishable regarding their sex both genotypically and phenotypically. (*b*) A pair of ascospores conjugate and give rise to a sporezygote which on germination gives the typically elongated vegetative cells. (*c*) Direct diplodization of the ascospore nucleus takes place, *i.e.*, the daughter and the mother nucleii fuse in the ascospore itself without giving rise to a bud. On germination, this diplodized zygote gives rise to the vegetative cells directly. It is this behaviour that was responsible for the older conception of the parthenogenetic origin of ascospores in saccharomycetes.

The study of the germination behaviour of ascospores in successive generations of cells, revealed that ascospores from yeasts originating from diplodized zygotes have such a low germinating power as to render the yeast almost sterile. This sterility, according to Prof. Winge and his collaborator is due to the effect of inbreeding on the cytoplasm, particularly, to the maldistribution of chondriosomes amongst the ascospores.[6]

It will be noticed that no work has been done on the chromosome complement in these yeasts. Though the genetical work leaves no doubt as to the reality of the alternation of generations in saccharomycetes; for scientific completeness the chromosome counts in the haploid and diploid phases is necessary.

Winge and Laustsen[2] demonstrated the genetic segregations in the ascus of a variety of *Saccharomyces ellipsoideus*. Their method consisted in isolating all the four ascospores from an ascus by means of the microtechnique and growing them into giant colonies individually on gelatine. In a typical experiment, two spores germinated forming haploid cells and the remaining two germinated directly into diploid cells. Apparently the latter two ascospores were diplodized zygotes. Of the former two haploid cell microcolonies, one was observed to produce cell zygotes while the other remained sterile, *i.e.*, all attempts to induce zygote formation failed. The cells of this sterile segregate resembled Toruloid yeast. The cell zygotes of the other microcolony behaved normally (*i.e.*, they produced actively budding vegetative cells) and *also* sporulated immediately on transference to the plaster block, thus strongly recalling the sporulating behaviour of Zygosaccharomycetes. The easily observable macromorphological features of these four segregates on gelatine, three being diploid giant colonies and the remaining one being sterile haploid giant colony, strikingly demonstrated the genetic segregation in the ascus. In this connection, two other points must be stated: the segregating types are not identical from ascus to ascus and there is not always pairwise identity in the four giant colonies. The former fact shows that macromorphological features are multifactorially controlled and the latter fact shows that crossing-over is not infrequent during reduction division.

In two subsequent papers[3,4] the authors present results of their extensive work on artificial hybridization amongst the members of the genus Saccharomyces, resulting in no less than fourteen hybrids, some interspecific and others

being intervarietal hybrids. The method of bringing about the cross was to bring the two spores of the parent yeasts in a droplet of wort and to observe under the microscope the spore zygote formation. This is achieved only after a number of trials, since it is purely a matter of chance that the two spores should germinate simultaneously and effectively conjugate.

The interspecific cross between *Saccharomyces ellipsoideus* (baking yeast) and *S. validus* has been presented by the authors in great detail.[3,4] An attempt is made to summarise the results in the following table:—

	Baking yeast	*S. validus*	*Hybrid*
1. Cells ..	Oval	Elongated	Oval but distinguishable from cells of the baking yeast
2. Sediment in wort ..	Smooth	Highly granulated	Intermediate to that of parents
3. Giant colony ..	Circular in shape with delicate silky radiate striation	Very irregular outline, rough sculpture of irregular concentric and radiate winding, deep furrows twisted almost like a cerebral	Intermediate to a certain extent, with pronounced concentric and radiate furrows and irregular outline
4. Germinating capacity of the ascospores	68 per cent.	78 per cent.	2 per cent
5. Biochemical character ..	Ferments only ⅓ of raffinose, *i.e.*, the yeast produces raffinase but not melibiase	Ferments raffinose completely and hence produces both raffinase and melibiase	Ferments raffinose completely, showing thereby that the presence of an enzyme is dominant over its absence
6. Rate of dry matter production	90 mg. in 72 hours	Variable but definitely at a much lower rate than its mate and the hybrid	98·6 mg. in 72 hours
7. Common method of zygote formation	Spore zygote	Spore zygote	Spore zygotes not formed or formed extremely rarely

The table is to a certain extent self-explanatory; two points may be noted. Firstly the low germinating power of the above hybrid is a general phenomenon common to all interspecific hybrids; in fact, low germinating capacity (0 to 13 per cent.) and high germinating capacity (50 to 94 per cent.) of the various hybrids are taken as indicative of specific differences between the parents. Secondly, specific differences in germinating capacity are accompanied by biochemical differences in fermentation.[4]

Of pure genetical interest is the author's work[5] on *Saccharomycodes Ludwigii* Hansen which has been proved to be a balanced-heterozygote involving heterothallism in the haploid phase.

The scientific and economic importance of these researches can hardly be overestimated. Scientifically this work will go a long way in clearing up the taxonomy and phylogeny of the genus Saccharomyces and other genera like Torula and Zygosaccharomyces. For preserving the constancy of type, Hansen's single-cell pure culture must be replaced by single-spore pure cultures. Systematic breeding work for obtaining yeasts of desired quality has now been rendered possible.

B. SRINIVASAN.

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[1] Winge, O., *Compt. Rend. Trav. Lab.*, Carlsberg, 1935, **21**, 77.

[2] — and Laustsen, *ibid.*, 1937, **22**, 99.

[3] — —, *ibid.*, 1938, **22**, 235.

[4] — —, *ibid.*, 1939, **22**, 337.

[5] — —, *ibid.*, 1939, **22**, 357.

[6] — —, *ibid.*, 1940, **23**, 17.

SCIENTIFIC RESEARCH AND THE FUTURE OF INDIAN INDUSTRY

IN the course of the third Sir J. C. Bose Memorial Lecture, on Scientific Research and the Future of Indian Industry, Professor Sir S. S. Bhatnagar drew attention to the lukewarm interest taken by the Government in the promotion of scientific research and to the utter lack of appreciation on the part of our industrial magnates to the possibilities of scientific research in relation to industry and the sophisticated and too philosophical a view which the scientists themselves have taken of their discoveries. Even under these difficult conditions, Sir P. C. Ray started the Bengal Chemical and Pharmaceutical Works, which is to-day, one of the principal flourishing industries in the country. He referred to the Tata Chemical Works at Mithapur which promises a new era in our planned industrial programme under the leadership of Mr. Kapilram H. Vakil. The efforts of the Alembic Chemical Works in Baroda, the activities of the Mysore Government, the Kashmir Government, Messrs. Shambhu Nath & Sons, Messrs. D. Waldie & Co., Messrs. B. K. Paul & Co., Messrs. Smith Stanistreet & Co., and the Baluchistan Government, point to a new renaissance in Indian Industry. These developments will give a fillip to scientific research which no other movement has yet been able to impart.

Professor Bhatnagar then referred to the part which the universities in the country had to play in the industrialisation of the country. The portals and laboratories of the university contain the wealth of talent, learning and imagination waiting to be tapped. He pleaded for a closer contact between industry and the universities and paid a tribute to the Universities of the Punjab, Calcutta, Bombay, Benares and Nagpur, which provide facilities for technical training and industrial research.

He drew attention to the several new industrial enterprises, like the manufacture of chlorine and bleaching powder, of nitric acid from synthetic ammonia, of benzene and toluene from coal, and of aviation lubricants.

The greatest scope for India, he declared, lies in her ability to make good by indigenous production what now constitutes a shortage in Indian industry owing to restricted imports and this presents a vast field of investigation for the technical man and the universities. In this connection he suggested the manufacture of textile machinery and textile auxiliaries—bobbins and shuttles, pickers, varnishes for healds, etc. The Board of Scientific and Industrial Research and the technical men are fully alive to the need of taking up such investigations of a character which will lead to the manufacture of auxiliaries for industries already well established in the country. The textile department of the University of Bombay, the Cotton Technology Institute and the Imperial Institute of Sugar Technology, are helping the textile and sugar industries in every possible way.

Professor Bhatnagar then gave a short resume of the research activities of the Board of Scientific and Industrial Research, which are being carried out under the auspices of fifteen research committees. He pointed out that the Indian investor should particularly investigate the possibilities of developing uses for the raw materials whose exports were so large from this country, that their disposal now constitutes a serious problem. Vegetable oil seeds, bones, and skins and leather wastes fall into this category. It is imperative that India should develop these industries in which oils and oil-seeds can be consumed. The utilisation of bones and leather wastes should also result in the development of several subsidiary industries. With the passing of the Scandinavian countries into German hands, the production of newsprint and paper pulp in India has acquired an altogether different aspect and the possibilities in these lines are being explored.

He then referred to "some laurels" already won by investigators in India in the field of industrial research. The development of the neutral glass industry by Prof. Nag and his associates, the discovery of a low-priced source of pectin by Dr. Krishna, the production of non-radio-active luminous paints by Drs. Bhatnagar and Parthasarathy, the improvement of the quality of cheap wood by impregnation with natural resins, the preparation of transparent films of great stability from halogenated rubber, the manufacture of high-grade paints and varnishes from marking nut developed by Dr. Siddiqui, the production of fibre boards and the employment of vegetable oils as diesel fuel developed by Dr. Verman, are but a few of the notable achievements.

He concluded, "Let us not forget that scientific and industrial research in this country has its handicaps. We are overburdened with all sorts of other duties. Our trade and our laws are occasionally not quite helpful, nor can it be said that political considerations do not come in the way of some of the investigators".

INDIAN CENTRAL COTTON COMMITTEE

(Conference of Scientific Research Workers)

THE Second Conference of Scientific Research Workers on Cotton, over which the President of the Committee (Mr. P. M. Kharegat) presided, was held in Bombay on the 19–21 January 1941. About fifty workers engaged in cotton research all over India attended the Conference and 45 papers covering all aspects of cotton improvement—"Cotton Genetics and Breeding", "Cotton Agriculture", "Cotton Technology", "Cotton Statistics" and "Cotton Pests and Diseases"—were read and discussed.

The first day of the Conference was devoted to the discussion of problems connected with "Cotton Genetics and Breeding" and "Cotton Statistics". A plea was put forward for a complete survey of cottons in Eastern Bengal, Assam and Burma and the need for a more intensive programme of hybridisation of cottons in India for purposes of isolating better quality types was also emphasised. In view of the prospect of the evolution of types combining the high yield and better quality of the American cottons with the hardiness of the Asiatic types, much interest was evinced in the research work on Asiatic-American crosses which was being developed at Surat. The problem as to whether there is a place for highly prolific, exceedingly short staple cotton in India was also discussed and the view was held that such cottons, under present conditions, would command a limited market.

The papers on "Cotton Agriculture" and "Cotton Technology" were considered on the second day. Considerable discussion, from the purely agricultural standpoint, took place on the effect of growing mixtures of cotton varieties on the incidence of pests and diseases on such cottons and the quality of lint. It was reported that in the Malwa tract where this practice was in vogue, the bollworm attack on Upland Cotton and the incidence of wilt in the Malvi type had considerably decreased with, at the same time, an improvement in the quality of lint compared with that of the local. Observations in Hyderabad, however, indicated that the characters of mixtures of pure *desi* types experimented with were more or less intermediate in comparison with those of the pure strains. In this connection it was mentioned that in the Punjab the incidence of root rot had appreciably decreased in cotton grown with other crops like sorghum and moth.

In the discussion on the manurial problems of cotton, stress was laid on the necessity of greater experimentation being carried out on cultivators' fields with the use of simple designs of lay-out.

In the Technological Section the influence of environmental conditions, such as atmospheric temperature and humidity, time of sowing, change of place and duration of crop, on the fibre properties of cotton received much attention.

The work done at the Technological Laboratory in connection with the prediction of the approximate spinning performance of a cotton from its fibre properties was reviewed. It was pointed out that in the older investigation by taking six fibre properties into consideration it was possible to account for variation in spinning quality in 86% of the cases, while the more recent investigations indicated that by taking the properties—fibre length, fibre weight per inch and swollen hair diameter—it is possible to account for some 89% of the variation. These investigations suggested a new method of attacking this problem as a result of which the importance of swollen hair diameter and length irregularity percentage was established. Investigations are, however, still in progress and details will in due course be published in the form of a bulletin.

The third day of the Conference was devoted to consideration of the problem involving the breeding of a 100% wilt-resistant cotton. The technique developed in Poona where work of this nature is being carried out under the supervision of the Plant Pathologist to Government with the aid of a grant from the Committee has given very encouraging results. It was pointed out that in the matter of the control of pests and diseases, the evolution of resistant types possibly plays an important part and accordingly close co-operation between entomologists, plant pathologists and breeders was emphasised.

The President in his concluding remarks emphasised the need for greater co-ordination between the various technicians and scientific workers and stressed the importance of designing means for making the results of research available to the cultivator.

INDIAN SCIENCE CONGRESS, BENARES, 1941

Summaries of Addresses of Presidents of Sections

1

MATHEMATICS AND STATISTICS

President: DR. M. R. SIDDIQI

FUNCTIONAL ANALYSIS AND MATHEMATICAL PHYSICS

A VERY important problem of Mathematical Physics is the unification of various theories connected with the different branches of this science. The task demands the creation of very powerful tools of mathematical analysis. Such tools have been developed since the beginning of the present century, and consist of the various topics in Functional Analysis.

The considerations of Abel and Liouville in the early part of the 19th century gave rise to a vast number of inversion formulæ for definite integrals which were later called "Integral Equations". Volterra, Fredholm and Hilbert developed since 1900 an extensive theory not only of the solution of integral equations, but also of the eigenvalues and of the Fourier-expansion in series of eigenfunctions as well as that of application to mathematical and physical problems. Integral equations have now become indispensable in many theories in geometry, analysis, and the whole domain of mathematical physics. The modern theories of ordinary and partial differential equations cannot be conceived without the theory of integral equations. Direct applications of this theory, without the mediation of differential equations have been made to statistics, kinetic theory of gases and the theory of radiation.

It is now recognised that evolution is not only of the non-hereditary character dealt with in classical mechanics and physics. These classical theories were based on the principle that the present state of a system determines all its future states. This determinism is a consequence of the conception that each action manifests itself only at the instant when it takes place, and leaves no heritage. This is the same thing as the assumption that the system does not conserve the memory of those actions which have affected it in the past. But all the phenomena of nature are not really produced in this way. There are a number of evolutionary phenomena in which heredity and memory play an essential role, and to which the theory of differential equations cannot be applied. The analysis proper to such phenomena is that of integro-differential equations.

When the theory of linear integral equations was built up in close analogy with a system of linear algebraic equations, it was natural to enquire whether the considerations could not be extended to non-linear integral equations. Such extensions have been made for solutions "im-kleinen" as well as "im-grossen", and Levi-Civita's problem of the propagation of two-dimensional surface waves of finite amplitude, Carleman's problem of the theory of heat radiation, the inversion problem in the theory of functionals, the equilibrium figures of rotating fluids, the dynamics of incoherent gravitating media, etc., can only be treated with the help of non-linear integral and integro-differential equations.

For the further development of functional analysis the introduction of the principle of passing from finite to infinite into the theory of determinants was of considerable significance. This made it possible to build up a theory of infinite systems of algebraic equations in complete analogy with the theory of finite systems. Thus originated the idea of functions of an infinite number of variables. Hilbert developed a systematic theory of infinite linear, bilinear and quadratic forms, and deduced from this the whole theory of solution and the theory of eigenvalues of integral equations. Hilbert's theory of infinite bilinear and quadratic forms provided also a very powerful method for the treatment of boundary value problems for ordinary and partial differential equations. A theory of infinite matrices and of principal-axes transformations was also developed which supplied the mathematical foundations for modern quantum mechanics. The geometry of Hilbertian space has been applied to formulate the generalised absolute differential calculus which includes Ricci's tensor calculus as a particular case.

Apart from Mathematics, functions of infinitely many variables have an important bearing on natural philosophy. If we consider a phenomenon as the effect of a finite number of causes, we are making only an abstraction because we are neglecting elements which are supposed to be very small compared to others which are taken to be preponderant. In this way we make only an approximative study of the phenomenon, for a full and complete study of which it would be necessary to pass from a finite to an infinite number of variables.

From a consideration of the variation problems, Volterra was led to 'functions of lines' which are now called "functionals". Functional analysis has developed along various lines corresponding to those of the theory of ordinary functions. It has penetrated deeply into the various branches of pure and applied mathematics. Everything concerning integral and integro-differential equations, investigations on functional spaces, the calculus of variations with its diverse applications in mathematical physics, questions involving effects of hereditary type—all these different subjects have now been unified in one general theory of functionals. Moreover, the functional method gives us a ready criterion for examining whether the various expressions for natural laws are in an invariant form agreeing with modern relativistic conceptions.

Recently, a general analysis has been developed in which the concrete variables of the infinitesimal calculus have been discarded, and

relations are studied between two elements of any nature whatsoever. This new analysis proceeds by making an abstraction of all those concepts which are common to several known and allied theories. These are then generalised by removing from them any particular properties that are related to the concrete elements on which they are based. This has given rise to the general theory of "functional operators" which has now become an essential part of many of the most important domains of mathematics. In it we see the methods of classical mathematics blending harmoniously with those of modern mathematics, bringing about a certain unity in different branches sufficiently remote from each other. A really profound insight into many important branches of mathematics such as the theory of functions, integral and integro-differential equations, calculus of variations, theory of sets, topology and theory of dimensions is possible only with the help of functional operators.

Modern theories of physics make much use of the operator calculus. Thus, apart from classical mechanics and electro-dynamics, the subject of quantum mechanics in its modern developments is based entirely on the theory of linear operators. This theory plays the same part in quantum mechanics as tensor analysis plays in relativity mechanics. Quite recently the quaternionic operators have been applied to relativistic quantum mechanics.

Functional analysis has developed extensively during the last few years, and has penetrated deeply into mathematics, mechanics, mathematical physics, statistics, biology and sociology. It is one of the most powerful tools of research in contemporary mathematics.

6

BOTANY

President: DR. S. RANJAN

THE RESPIRATION OF PLANTS IN LIGHT

IN the case of non-green leaves of croton containing carotinoid pigments and the flowers of *Bougainvillea* and *Nerium,* the respiration rate in light appreciably increases. The respiration rate of a green leaf in light also increases, but due to photosynthesis the respiration rate is to a greater or lesser degree marked. Therefore to find out the true rate of respiration of a green leaf in light is to study the dark respiration after a period of illumination. The respiration rate of this dark period at first increases up to a point and then decreases. If this falling curve is produced backwards to the point when light was cut off or to the zero hour of darkness, then the respiration curve of darkness will show an L-shaped fall. The high point touched at the zero hour of darkness is the respiration rate in light while in darkness the respiration rate steadily falls off. This steadily falling off respiration curve is similar to the "floating respiration" of Blackman which is nothing else but the "after effect" of light. The following scheme for light respiration is suggested.

$$\text{Carbohydrates} \xrightarrow{\text{Hydrolysis}} n(\text{Glucose})$$

Primary reaction (Photochemical or thermal)

$$2\ \text{Glucose} + h\nu \longrightarrow \text{Glucosé} + \text{glucose}$$

Secondary reaction (Thermal)

$$\text{Glucosé} + \text{En} \longrightarrow 2C_3H_6O_3 + q$$

$$2\ \text{Glucose} + q \longrightarrow \text{Glucose} + \text{glucose}$$

$$\text{Glucosé} + \text{En} \longrightarrow 2\ C_3H_6O_3 + q$$

and so on.

N.B.—En = Engyme.

$q = h\nu +$ the difference of the energy between $C_6H_{12}O_6$ and $C_3H_6O_3$.

$h\nu =$ is the photonic energy (h is Planck's constant, V the frequency of light).

The above scheme of reactions suggests at least two reactions involved in respiration.

(1) The primary reaction which is both thermal and photochemical and (2) Secondary reaction which is purely thermal. Further support is given to the above scheme of reactions by the work on the temperature effect upon respiration in light. It has been found that in the case of Eugenia leaves—which is a tropical plant—the maximum rise in the respiration rate in light is at 27° C. This increase decreases with higher or lower temperatures. Now, according to the above scheme let us suppose that in the chain of reactions $A \rightarrow B \rightarrow C$ the first reaction, *i.e.*, A to B is Photochemical and B to C chemical. The rate of B to C will depend upon the rate A to B.

In dark at 20° C. both A to B and B to C are slow and the rate of respiration is consequently slow. If light is given A to B gets accelerated while B to C remains slow. Thus the reaction is limited by the rate of B to C.

At 27° C. the rate of respiration augments in light because B to C is no longer limiting.

Now as the activation of the reacting metabolites in the primary process can be brought about both by light and temperature, then if the temperature is greatly in excess a large number of molecules will already be in an activated state and with light the increase in activation will be proportionately less. Thus the increase in respiration proportionately decreases in light beyond 27° C.

The increase of the primary process or the increase of respiration in light will only take place, if the respiring organ is coloured. Colourless plants like fungi or the roots of plants show no increase in respiration in light, for the simple reason that light of the necessary frequency is not absorbed.

On this scheme the falling respiration curve of leaves which is called the floating respiration by Blackman is really the 'after effect' of light. Because the energy q given out in the reaction is enough to activate a second molecule of sugar and light energy after the first reaction, the value of hV will not be required. Theoretically the reaction once commenced in light shoud go on at the enhanced rate in darkness, but due to the gradual dissipation of energy q the respiration in darkness comes down to a slower rate.

8

ENTOMOLOGY

President: Y. RAMACHANDRA RAO

SOME OBSERVATIONS ON THE PERIODICITY OF LOCUST INVASIONS IN INDIA

IN the broadest sense of the word, a "Locust" is a grasshopper capable of appearing in large swarms and causing considerable damage to crops. While there is little difference in general appearance and structure, the grasshopper lives a solitary life scattered in small numbers all over the area, whereas the locust tends to congregate together both in the younger stages as hopper bands and in the adult condition as flying swarms.

There are three most important locust species in India: (i) the Migratory locust; (ii) the Bombay locust; and (iii) the Desert locust. The first is found in its solitary phase all over India; but there are indications that it can occasionally assume gregarious habits and become a destructive pest; the second is endemic in the region of the Western Ghats and usually visits the neighbouring districts of the Bombay Presidency. Its swarms invade also, Kathiawar, Central India, Central Provinces and parts of Madras and sometimes extend as far as U.P., Bihar and Bengal. Since 1910 this locust has not, however, occurred in a serious form. The third is the locust *par excellence* of India and is usually found in the desert regions of N.W. India, but during years of mass multiplication, may invade, upto Assam in the East, and right up to the northern districts of Madras in the South. This species has the ability to pass through two or more generations in rapid succession in a single year and assume the dangerous swarming condition under favourable circumstances. As this species has been the subject of special investigations in India since 1930, much information has been gathered in respect of its periodicity and various other factors.

When locusts appear they are seen at the same time in many parts of India either breeding or migrating, the extent of spread being considerably greater in years of high multiplication; during the intervals between locust cycles, few locusts are noticeable anywhere in India. During the recent swarm-free period, 1932–39, investigations financed by the Imperial Council of Agricultural Research, were in progress, regarding mainly, the habits, ecology and distribution of the nongregarious locusts found in the desert areas; these locusts are found to react to changes in the environment exactly in the same way as the gregaria phase locust; their breeding is similarly dependent on favourable rainfall and they migrate over long distances at the change of seasons from one rain belt to another and goes through at least two generations a year, one in winter-rain areas and the other in summer-rain areas. The main difference would appear to lie in the crowded life lived by the gregaria locust and in the high intensification of its activities under the influence of mass psychology. In the present state of our knowledge the change in status of an apparently innocuous, obscure, and sparsely distributed resident locust of the desert, into a highly dreaded pest, capable of appearing in vast hordes and dealing wholesale destruction to crops, would appear to be due mostly to its reaction to a complex of meteorological factors favouring its breeding under crowded condition.

The general sequence of events during a year of locust swarm activity may be roughly classified under (1) over-wintering, (2) spring breeding, (3) summer breeding. And the causes for the breakdown of the infestations are most probably, (1) failure of the swarms produced in the eastern areas in summer to reach the winter-rain zone and (2) failure, or very low seasonal rainfall tending to diminish greatly the extent of breeding and multiplication.

In the study of the ecology of the solitary phase, the main problem is to determine the conditions in which groups of solitary individuals become transformed into gregarious swarms. Since eggs are generally laid under crowded condition, the hoppers hatching therefrom, tend to get crowded and form incipient hopper bands later developing into the primary swarms of fliers. Such situations as these where phase transformation is brought about, are termed "outbreak centres".

The sequence of events in the origin of a locust cycle appear to be (1) heavy and well-distributed rainfall in the winter-rain areas causing the formation of outbreak centres with incipient swarms; (2) the conveyance of these swarms into the desert area at the right time for monsoon breeding; (3) occurrence of heavy and well-distributed monsoon bringing about concentrated and continuous breeding in the desert leading to the building up of large swarms.

The importance of taking adequate and timely measures in checking the initial outbreaks cannot be overemphasised. The best way of dealing with them would be to locate the centres of outbreaks and destroy the incipient bands of hoppers before they develop wings and leave the area.

The influence of the fluctuation of sunspot activity on locust incidence has been recognised by many authorities and this phase of locust investigation comprises a fascinating study.

Although a considerable advance has been made in a study of locust epidemiology there are still various gaps in our knowledge of locusts, especially in regard to problems of a fundamental nature and it is hoped that necessary funds for their investigation, while the material for study is available during the present swarm period, will be forthcoming.

12

PHYSIOLOGY

President: DR. B. B. DIKSHIT

SCIENTIFIC STUDY OF SLEEP

IN his Presidential address delivered before the "Physiology Section" of the 28th session of the Indian Science Congress held at Benares in January 1941, Dr. B. B. Dikshit, PH.D., M.R.C.P., M.B.B.S., D.P.H., records "Some observations on sleep" in the hope that his observations may urge young physiologists to pursue investigations of the familiar but, in some respects, baffling phenomenon of sleep. He notes that "most of the literature on sleep is in German, some in French and comparatively little in English" (P-2). In the opening section, Dr. Dikshit sums up a few observations on the physiological changes in sleep with reference to circulation, respiration, muscular movements and secretion of sweat. That sleep is a "parasympathetic phenomenon" is next noted. Sir Henry Dale had pointed out in 1934 that there is an intimate relation between parasympathetic and acetylcholine. If so, the question has to be posed and problem solved whether "acetylcholine is the sleep-producing hormone". Dr. Dikshit then briefly refers to the "Chemical theory of sleep", to "sleep centre" localized and identified in the third ventricle of the brain, to "cortical" and "sub-cortical" theories of sleep, and enumerates certain experiments conducted with a view to identification of the substances that act as sleep-producing hormones. Dr. Dikshit inclines to the view that a majority of considerations would point to *acetylcholine* being pre-eminently the sleep-engendering hormone. What is the action of acetylcholine on sleep-centre? Does it exist normally in the brain? Is there a special mechanism to control its action? Does its pharmacological action agree with the physiological changes observed during sleep? Is there accumulation of it in the sleep centre? These and allied questions are answered next and the concluding section is devoted to a discussion of methodological procedure and results obtained so far. Three important conclusions emerge from Dr. Dikshit's presidential pronouncement: (1) The sub-cortical centres are responsible for sleep. (2) There is a sleep-centre in the hypothalamic region. (3) Acetylcholine may be claimed to be a sleep-producing hormone and it activates the sleep-centre.

It may not be out of place, nor would it require any special pleading to observe that papers and presidential pronouncements, wherever possible of the Indian Science Congress, and of its different sectional ramifications, should occasionally at least endeavour to examine theories put forward in ancient Indian classics. The phenomenon of sleep affords undoubtedly the most fascinating subject of investigation, and Dr. Dikshit may have briefly surveyed the ancient Indian theories ignoring the fact that they of course were not formulations arrived after experimental investigation and laboratory analysis of the type now available. The Upanishadic theory of sleep may perhaps supply the clue to modern experimentalists. In the acute analysis of the state of sleep, perfect, undisturbed and dreamless sleep (*sushupti*) the Upanishadic thinkers have pointed out that the cortical centres are as much responsible for sleep as the sub-cortical so that for any theory or hypothesis to be complete, comprehensive, and inclusive of all the known facts and data, inclusion of both cortical and sub-cortical influences would be indispensable to account for sleep. That sleep is a parasympathetic phenomenon had been quite clearly realized by the Upanishadic thinkers. In their analysis, they pointed out that the entire *tout ensemble* of sensory-motor mechanism remains suspended during the time of sleep. (*Jnyana-karmendriya-uparati.*) But, then, only the *Chitta* is still active which renders possible personel identity and continuity of self-consciousness—such as "I had a sound sleep up till now". I wish Dr. Dikshit had made some brief reference to the theories of sleep advanced by the Ayurvedic teachers.

To many a teacher who is day in and day out confronted with the phenomenon of pupils falling asleep even during the first hour of the day undoubtedly as the result of a hurried meal and walking to the class-room, the problem of sleep must appear intriguing. On the contrary hundreds of students have complained to me that the soporific accents in which learned professors endlessly go on reading from the printed pages even without caring to face the audience straight, have invariably induced sleep in them however eager they might have been to "learn".

Is sleep at all necessary as a physiological necessity? The Yoga system has prescribed courses of practices by means of which sleep can be controlled. Certain practices lead to insomnia. To counteract it, other practices are detailed which plunge the subject in the bliss of deep, dreamless sleep. The ancient Indian thinkers had perfectly realized the value of sleep as a tissue-building reconstructive tonic.

The problem of sleep is by no means restricted to physiological treatment. It is psychological and its frontiers touch general philosophy. The Upanishadic thinkers saw that waking, dreaming, and sleeping should be viewed as triune or tripartite, so that abnormalities in one invariably found reflections and repurcussions in the other two. These problems deserve careful investigation. I commend Dr. Dikshit's address as an eminently able survey of the latest literature and theories on the problem of sleep.

R. NAGA RAJA SARMA.

13

PSYCHOLOGY

President: DR. I. LATIFF

PSYCHOLOGY AND THE FUTURE OF MANKIND

"THERE are only two alternatives; it is either re-education of man, or the catastrophy of his cataclysmic extinction. This presents to psychology its present task." In this rather alarmistic and challenging manner Dr. I. Latiff,

M.A., PH.D., concludes his address delivered as President of the Section of Psychology and Educational Science of the 28th session of the Indian Science Congress held at Benares in January 1941. In the opening section, Dr. Latiff refers to the "tragedy that attends the march of human affairs", and records in pathetic strains that "mental disorders, crimes, political unrest, wars and unhappiness dog its steps at every turn" (P-3). In the second section, he complains that the "leading intellectuals" are ignorant of the real causes of these disorders. Quoting fairly extensively from the work of Samuel D. Schmalhausen, he points out that man's behaviour should be studied from the standpoints of psychology and psychiatry and not from those of sciences like economics. Incidentally he observes that the hostility to psychology should be directly due to many a skeleton in the cupboard of the mental-make of these distinguished modernists. In the *third*, Dr. Latiff goes on to explain that notwithstanding the claims and achievements of modern civilized man, there exists "behind the facade of rational conduct, a primitive mental structure which regulates his individual and social life" (P-8), and which is perhaps responsible for the manifold maladjustments of mankind. That the existence of the primitive savage elements in modern civilized mankind is not realized on account of Repression, and Projection, and that conventional morality and religion are nothing but neurotic manifestations are explained in the *fourth*. In the *fifth* concluding section, a strong plea is entered for the use of scientific psychology in effecting mental and emotional re-adjustments imminently incumbent on human society to-day. How can scientific psychology help? Firstly, instinctual demands should be gratified within reasonable limits without the imposition of irrational restraints. Secondly, Psycho-analytic treatment should be made available more generally than at present. The work, thirdly, must begin in the nursery. Psychological clinics for children should be started. Fourthly, parents and teachers should be educated along the lines of scientific psychology. Fifthly, carefully graded sex-education to suit the psycho-sexual development of individuals should be imparted. Finally, as vocation is influenced by unconscious motives, psychology and psycho-analysis should be pressed into service in selection of vocation.

I have fairly carefully perused the 25 pages of closely printed matter of Dr. Latiff's Presidential address, and I feel like old Khayyam that I have come out by the same door as in I went trite as the comment may seem. In the interests of disinterested scientific investigation it must be emphasized that as between non-recognition of the value and significance of psychology and psycho-analytic technique in the colossal task of re-education of mankind, and overdoing and making a fetish of psychology, psychiatry, and psycho-analysis, the latter is undoubtedly more dangerous. A million Freuds notwithstanding Religion cannot be so easily dismissed as an evolutionary manifestation of infantile or savage FEAR. Be that as it may, the manifold miseries and maladjustments to which modern mankind has fallen a prey, are not after all so much due to occasional eruption into consciousness of hidden primitive motives and instincts, as actually to very visible and manifest tendencies. Dr. Latiff makes mention of the well-known sadistic and masochistic tendencies, and I wonder what reception would be accorded to the psycho-analytic explanation or hypothesis if Dr. Latiff were to argue that Mr. Gandhi's *fasts* are mere manifestations of masochistic tendencies seeing that fasts are certainly a species of ascetic self-torture.

That is why Indian psychology while emphasizing the value of deep-seated tendencies, dispositions, complexes, primitive instinctual desires and motives (designated by the all-comprehensive *samskara*) rightly insists on an adequate analysis of openly expressed behaviorism and overtly operating motives and springs of action. Thus, there is absolutely no need for an onlooker like Wendell Willkie to attempt the impossible task of psycho-analysing the Fuehrer for isolating and identifying the war-guilt!! Overt behaviourism must quite suffice. Formation and crystallization of opinion cannot be arrested when one finds that a strong military nation simply because it is strong and powerful invades its weak neighbour. That must kindle the righteous indignation of all without any otiose and unprofitable attempt at psycho-analysis of the aggressor.

It is all so easy to talk of educating the parent and the teacher on the lines of scientific psychology. But, who is to educate the psychologist and the psycho-analyst? Can he like the King do no wrong? Of course these and allied questions genuinely germane to the subject selected by Dr. Latiff are not even touched on, but, that need not prevent one from commending Dr. Latiff's address as a fine performance.

R. NAGA RAJA SARMA.

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ENGINEERING

President: DR. C. C. INGLIS

HYDRODYNAMIC MODELS AS AN AID TO ENGINEERING SKILL

SOME hydrodynamic models give accurate results, others yield results widely diverging from those of the prototype.

Geometrically similar models constructed for determining coefficients of discharge, standing wave relations, study of lines of flow at off-takes, and scour downstream of falls yield results with a fair degree of accuracy. But experiments conducted at Poona, on geometrically similar models to determine the coefficients of a high coefficient weir and to study the slab movement in the submersible bridges have not yielded similar results.

Usefulness of models with a mobile bed is well exemplified in the experiments on the flow round a bridge pier constructed in erodible sand in which "flow pattern" is the dominant factor. In 1938–39 Annual Report of the Central Irrigation and Hydrodynamic Research Station, it

is shown that scour, at pier noses, is due to the water, diverted by the pier, diving downwards towards the upstream toe of the pier. The action of scour is due to the 'flow pattern' and is scarcely affected by the upstream bed level.

Rigid vertically-exaggerated models, though with great care may be made to reproduce correctly conditions for a given discharge, may fail with longer or smaller discharges. Much patient 'trial and error' work spread over a number of years along with large data may enable prediction of conditions outside the verified range. But direct informations about scour and consequent changes in flow cannot be got. A rigid model of a 20-mile length of the Hoogly above Calcutta is being studied at Poona to determine lines of flow and places of scour bed action, as preliminary, to a more exhaustive investigation of bank-scour problem with semi-rigid or mobile part-models, using larger discharges.

Semi-rigid models can reproduce similarity much more accurately than the whole mobile models. But throughout the length of the channel conditions are imposed, the model being incapable of scour, its banks being rigid or changing its course thus precluding studies of future changes of river course and their consequent effects.

In the case of mobile channels, as a result of Lacey equations, slope exaggeration must equal vertical exaggeration for the same silt factor in model and prototype. A coarser silt increases the slope exaggeration whereas it decreases the vertical exaggeration. Choosing of correct silt conditions in a model is thus very essential. Hence channels can be more satisfactorily designed by the use of formulæ than by model studies.

Silt movement and hence the amount of scour and silting are always relatively much less, in a natural mobile model than in its prototype. With a low discharge, silt movement will occur in rivers whereas in a model it will not commence till a flow is a considerable fraction of the flood discharge. Use of finer silt in models though increases silt charge, has little effect on the velocity at which silt movement begins and ends. In the 1/300 Sukkur Barrage model, when regulated as at the Barrage, silt movement does not begin till the discharge exceeds half the normal maximum flood discharge. In many river problems, scour after floods greatly affects subsequent flow conditions and this scour is not correctly reproduced in models, leaving us to depend either on experience and judgment or to distort the model scales to effect silt movement at low discharges.

Bank slopes and rigid structures are exaggerated according to the depth exaggeration scale. Such exaggeration fails to reproduce correctly the "flow pattern" thus necessitating recourse to large-scale part-models, essential for studying bank effect.

To prevent distortion in plan, models are foreshortened longitudinally in the ratio of the vertical exaggeration, this foreshortening leading generally to distortion of the lines of flow or eddy pattern, due to inadequate length.

Long and short river models have specific advantages but in both these cases, great care must be bestowed on entry condition as on its correctness depends a reliable reproduction of the meandering course of a river. Generally models varying from geometrical similarity to various scales of vertical exaggeration would be needed to help proper understanding.

For several years, various scale experiments have been conducted with mobile models at Poona, to study effects of variation of slope scales, discharge scales, silt charge and vertical exaggeration. They have indicated the limitations of river model studies; a wide range of experiments with large models generally yield highly accurate qualitative results with some measure of quantitative accuracy. Conditions that have existed in the prototype under a known discharge and silt charge, can be reproduced accurately in a model and at best, mobile river model can serve as a valuable guide to the engineer.

C. GOPALAKRISHNAN.

CENTENARIES

Cooper, Astley Paston (1768–1841)

ASTLEY PASTON COOPER, a British surgeon, was born at Brooke Hall about seven miles from Norwich 23 August 1768. His father was a vicar; but his grandfather and uncle were both surgeons. He passed a spirited boyhood without much schooling. He learned classics from his father and his mother, who was an authoress of no mean repute, taught him history and grammar. He was thus neither overtaught nor overstrained in his boyhood. When he completed his sixteenth year, he was apprenticed to his uncle, surgeon to Guy's Hospital, and later to Henry Cline, surgeon to St. Thomas's Hospital. He specialised in anatomy and completed his course by spending seven months in Edinburgh, in close association with the most renowned surgeons of that place.

In 1789 Cooper was appointed demonstrator of anatomy at St. Thomas's Hospital and two years later he was promoted lecturer. He followed the Hunterian model which was scoffed at by the elders. The students accustomed to the teaching of such scoffers began to desert Cooper. After investigation Cooper found that it was due to their ignorance of Hunterian terminology and their lack of experience. To counteract these difficulties, Cooper adopted the plan of bringing before the class cases of disease and injury and further illustrating by morbid specimens and experimental results. This method he practised with great success throughout his teaching career of forty years.

In 1800 Cooper was appointed surgeon to the Guy's Hospital. In 1805 he took an important part in founding the Medico-Chirurgical Society. Its *Transactions* contains several contributions by him. His two volumes on *Hernia* (1804–1807) are justly famous. In 1822 Cooper brought out his well-known *Dislocations and fractures of the joints.* In 1827, he became President of the College of Surgeons and in the next year he was appointed surgeon to the King.

In 1820 Cooper operated upon King George IV for a tumour of the scalp. This brought him a baronetcy. An anecdote connected with this operation shows the change in surgical practice that has come since those times. Cooper was summoned hurriedly to the Palace one evening. On his return he asked Bransby Cooper, his nephew, "Pray tell me, do you see anything particular about me, for the King did not seem in good tune; he looked very hard at me from head to foot, and I cannot understand why—do you see anything?" "Why" said Bransby, "I should have put on a white cravat and a clean shirt, or at least have washed my hands before I waited on His Majesty." The fact is, Sir Astley had performed a slight operation just before he went to the Palace, by which some blood had stained the sleeve of his shirt where it projected at the wrist, and his hands also were not perfectly free from it. Mr. Cooper then looking at what he had pointed out to him said "God bless me, so I ought, but I was not aware of it. The King, sir, is a very particular person; he was lying on a couch under a canopy with a red turban on his head, and he looked displeased and now I see the reason of it."

A statue of Cooper was erected in St. Paul's Cathedral. He died 12 February 1841.

Gregory, Olinthus Gilbert (1774–1841)

OLINTHUS GILBERT GREGORY, a British mathematician, was born of humble parents at Yaxley 29 January 1774. After studying in the village school, he learned Mathematics from Richard Weston, a botanist, with such good effect that as early as 1793 he published a small book of *Lessons, astronomical and philosophical.* He also wrote a book on the slide rule, which brought him to the notice of Charles Hutton, professor of mathematics at the Royal Military Academy at Woolwich.

In 1796 he settled as a bookseller in Cambridge and gave private tuition in mathematics. The latter occupation soon became so profitable that he gave up the bookselling business. In 1802 he was appointed mathematical master at the Royal Military Acadamy; and he became professor on Hutton's resignation in 1807.

He obtained honorary degrees from several institutions and became a fellow of the Royal Society. He was one of the original founders of the Royal Astronomical Society and one of the projectors of the University College, London. His name was inscribed in the foundation-stone of that college laid in Gower street, 30 April 1827.

He was a prolific writer. His *Treatise in astronomy* (1802), his *Treatise of mechanics,* 3v. (1806) and the *Elements of plane and spherical trigonometry* are the most well known. His works are characterised by sound knowledge, good arrangement and clearness of exposition.

Gregory died 2 February 1841.

S. R. RANGANATHAN.

University Library,
Madras.

SCIENCE NOTES AND NEWS

An Optical Hygrometer.—Dr. L. D. Mahajan, Physics Research Laboratory, Mahendra College, Patiala writes:—

An optical hygrometer has been devised in this laboratory in order to study the variation in the humidity of the air.

To a zinc rod (balance beam), about 1 mm. thick and 10 cms. long, a cup of zinc of 1 cm. square and 2 mms. deep is fixed rigidly to each end. In the middle of the beam, a revolving rod of copper, about 1 mm. thick and 7 mms. long, is rigidly attached at right angles to it. A small spherical mirror of about 2 metres focal length is fixed to the revolving rod, just on one side of the junction of the revolving rod and the balance beam.

The two ends of the revolving rod are made to rest on two fine, well polished and equally levelled glass plates fitted on a stand. One of the cups is filled with a powder containing about 97 per cent. Plaster of Paris and 3 per cent. calcium chloride. It has been found by various trials and observations that the mixture of these two powders has high power of absorption and desorption of moisture. Suitable weights are added into the other pan till the beam is almost horizontal.

A beam of light is thrown from a lamp and scale arrangement on the spherical mirror and the reflected beam is allowed to fall somewhere in the middle of a vertical scale at a distance of about 200 cms. from the revolving instrument. The whole instrument is placed inside a rectangular glass vessel perforated with holes at the base to permit free circulation of air inside it and to avoid any disturbance to the revolving arrangement due to any direct and strong currents of air. Then the instrument is ready for measurements.

With a small change in the humidity of the air, the spot of light moves through a great distance on the vertical scale. The shift of the spot of light is proportional to the change in the relative humidity of the air.

The author is indebted to His Highness' Government, Patiala, for having provided facilities to carry out this work in the Physics Research Laboratory, Mahendra College, Patiala.

December 21, 1940.

Archaeological Discoveries in U.P.—Important discoveries which might help in filling up the gaps in India's ancient history are expected to be made at Ramnagar in the Bareilly District of the United Provinces. The site has been identified as the city of Ahichchatra, the capital of ancient Panchala, which corresponds roughly to the modern Rohilkhand Division. The city is on an elevated triangular tableland of rolling mounds, covered with thick layers of bricks and potsherds, surrounded by a broad brick wall, rising in places to nearly 50 feet above the low plain outside. The wall shows bastions and angles at various points and is nearly three-and-a-half miles in circuit. The bricks used in the wall are unusually large, being 21 to 24 inches long, indicating an early age, from 100–300 B.C.

Except for a rapid survey, nearly 70 years ago, by General Sir Alexander Cunningham, the first Director-General of Archæology, the site at Ramnagar has received no attention from the Archæological Department. The present discovery ensued from a recently undertaken survey of promising ancient sites in the western United Provinces and systematic excavation is in progress under the direct supervision of the Director-General of Archæology.

Two high mounds, 30 to 50 feet high, stand inside the city and seem to be the remains of terraced temples, but there is nothing in the configuration of the mounds to distinguish different parts of the ancient city. A broad partition wall appears to run from north to south dividing the city into two unequal parts, the eastern one being smaller than the western. Excavations are in progress in the western part, over an area of about 350 feet each way, where several houses, lanes and streets have been brought to light.

The temples and houses of the city that has been exposed so far appear to belong to the epoch of the Gupta Empire — 400–500 A.D.— and there is little doubt that the ancient capital was evacuated sometime about the Hun invasions of the fifth century A.D. The city must have been in existence for nearly a thousand years before desertion.

As excavation proceeds layer by layer earlier occupations will reveal themselves. It is also proposed to dig trial trenches in an isolated mound in the eastern part of the city. This area, it is believed, was abandoned at an earlier period, sometime in the early centuries of A.D. and earlier settlements may be expected to be found nearer the surface there than in the western area.

The Stone Implements of Bandarawela, Ceylon.—N. A. Noone and H. V. V. Noone made a large collection of mesolithic-like stone artifacts in the vicinity of Bandarawela, and has described them in the *Ceylon Journal of Science* (Section G. Anthropology, Vol. III, part 1). The tools are mostly of quartz, and their occurrence has been reported by previous workers particularly, the Sarasins, Hartley and Wayland, but the present authors go into the details of the technique and classification. In the absence of stratigraphic evidence, no definite dating of the culture is possible, but for convenience the authors have designated it "Bandarawelian". The authors appear, however, to be not aware of the work done in central India, and of the occurrence of an almost similar culture in Tinnevelly. Quartz implements of very interesting and comparable types have been discovered in the Nellore District of the Madras Presidency by Dr. Frank P. Manley (*Curr. Sci.*, April 1940). The fresh data from Ceylon will thus be of great interest to prehistorians in India.

Glassfish Nutrition.—Mr. T. J. Job, Lady Tata Research Scholar, working in the Laboratories of the Zoological Survey of India, Calcutta, in the course of his investigations on larvicidal fishes, has made observations on Glassfish nutrition and its bearing on the control of malaria and guinea-worm. Food analyses, feeding experiments and field observations conducted by him in the 24-Perganas and in the malarious areas of the Hoogly Delta Section of the Bengal-Nagpur Railway, have revealed that (1) the mosquitocidal propensities of the Glassfishes (*Ambassis* Cuv. & Val.) are inferior to those of the Killifishes like *Aplocheilus* McClelland and *Oryzias* Jordan and Snyder, but that (2) the Glassfishes are remarkably effective in the destruction of cyclops in their natural environment. These observations are likely to prove of great value in the biological control of guinea-worm disease. Detailed results are in the course of preparation and will be published in due course.

Sizes of Plant Viruses.—Determination of sizes of viruses by the filterability and the ultracentrifuge methods have given, in a large number of cases, different values for the same virus. The discrepancy between the values obtained by these two independent methods, has now been traced to the circumstances that the viruses differ not only in size but also in shape. When the particles are spherical as in the case of the viruses of Tomato Bushy Stunt, Tobacco Necrosis and Tobacco Ringspot, the two methods give comparable values. The sizes of these viruses are respectively 27, 25 and 19 $m\mu$. In the case of particles which show anisotropy, our knowledge of the sizes is less accurate. The particles of the Tobacco Mosaic virus are known to be rod-shaped. The width of these particles as determined by different methods is in the neighbourhood of 13 $m\mu$. There is considerable variation in the estimates for the length of these bodies; for one thing, it is known that the virus particles can adhere end-to-end. Measurements with the electron microscope reveal that most of the particles in the infective sap have a length of 300 $m\mu$ while some others are only 150 $m\mu$ long.

Root-growth Promoting Substances and the Technique of their Use.—We may note that in India the use of the root-growth promoting substances like indole butyric acid, Indole acetic acid and similar compounds now being made

known largely by the work of the Boyce Thompson Institute for Plant Research in the U.S.A., has been studied very little and that no satisfactory results have been reported. The scope for vegetative propagation by the planting of cuttings is very great not only in the limited sphere of the plant breeder but also in the extensive field of commercial nursery and estate work. Its usefulness in the propagation of high yielding strains through seed which can be fixed and made to breed true only after successful breeding work carried out over many years is too obvious to be stressed; there is, in addition, in the case of multiplication the class of plants whose seedlings are too delicate and are subject to diseases attacking the roots and collar causing the death of innumerable seedlings in the early stages, like the clove, chincona and so on, and again the class of fruit plants in which earliness of fruiting resulting from vegetative propagation is a chief consideration in favour of the method.

The method of utilising these root-growth promoting substances is, however, not so simple as it may appear and many essential conditions have got to be worked out suitable both to the type of plants dealt with and the environmental factors that may prevail. Attention is pointedly drawn to these conditions by Henry Kirkpatrick Jr., in Professional Paper No. 30, Boyce Thompson Institute, for Plant Research, in regard to the rooting of evergreens. The conclusions of three years work bring out clearly the importance of a study of all these factors before success can be attained. It is stated, for instance, that cuttings of certain genera, such as cedrus and pinus, failed to respond altogether. Many limiting factors are indicated even in the case of plants which respond well; thus the time of the year at which the cuttings are taken, the type of cuttings used, the temperature of the propagating house and the rooting medium, the care of the cuttings during the rooting period and the strengths and methods of application of the substances—all are important controlling factors. The writer of this note can well appreciate this need for study of the factors before success can be had, as he attempted the method with a large number of different kinds of plants and tried as many as four different substances, *viz.*, Skatole, and three proprietory products called "Auxilin", "Seradix A" and "Hartomone", with none of these was any success worth mentioning obtained, nor any great difference noticed as against the controls, the conditions necessary for success under the local environmental, soils, seasons and the type of plants, the age of cuttings and so on not having evidently been worked out and known. We would strongly suggest this subject being taken up by plant breeders in India to a greater extent than at present.

A. K. Y.

Depth of Soil Sampling for Soil Analysis.—It is well known that the composition of soils in manurial experiments as determined in the usual manner of analysing six-inch depth samples does not disclose increases of nitrogen, phosphoric acid or potash where such increases would be expected as the result of fertiliser application, even when such applications are in doses far in excess of anything which may be thought of in practice on the field. In view of the fact that such increases can be expected much more in the top layers than those below, the desirability of analysing small-depth samples is coming to be recognised and considerable work has already been done on the subject elsewhere. In India the importance of small-depth samples is stressed as the result of work carried on in the Agricultural Research Institute, Nagpur (K. G. Joshi, in the *Nagpur Agr. Coll. Mag.*, 15, No. 1). Soil analysis in connection with certain manurial experiments on pasture land showed no significant differences in the composition of soils from manured and unmanured plots in soil samples of the usual six-inch depths. Small-depth samples were then decided upon and samples of every-inch-depth were then taken from the same manured and unmanured plots and analysed. Significant differences in both the phosphoric acid and nitrogen content were now noticed in top two one-inch sections and sometimes lower down also. Assuming the weight of soil per acre to a depth of six inches to be two million pounds, then the fertilisers added should be expected to show an increase of 0·012 per cent. of phosphoric acid, but the experimental error of 0·01 per cent. makes such increase not possible of detection. On the other hand the weight of an acre of soil only one inch deep will be only one-third million pounds and the increase due to manuring if concentrated in the top one-inch layer should be 0·07 per cent. which is much more than the experimental error and is easy of detection. The importance of taking small-depth samples is thus brought out—a matter which opens out very important possibilities in the interpretation of manurial experiments.

A. K. Y.

Paragonimiasis in China.—Paragonimiasis is a wide-spread disease in man and animals in China and H. T. Chen (*Lingnan Science Journal*, 1940, vol. 19, No. 4) has added considerably to our knowledge of this disease by his extensive studies on *Paragonimus iloktsuensis*. This species inhabits rats and its intermediate hosts are an amphibious snail, *Assiminea lutea* and two species of crabs, *Sesarma dehaani* and *S. sinensis*. The larval stages consist, as in other species, of miracidia, sporocysts, first and second generation of Rediæ, cercariæ and metacercariæ. Of these the metacercariæ are the most interesting. Their structure differs from the similar stages of other species. They have very thin walls and are easily broken, and are used as diagnostic features by the author for *P. iloktsuensis*. Experimental studies have shown that it is not possible to infect wild cats, pigs, guinea-pigs or monkeys with this species. A complete, profusely illustrated description of the anatomy and life-history of the species is given.

Coal Mines Stowing Board.—The *Annual Report* of the Coal Mines Stowing Board for the year 1939–40 which has been recently published, gives an account of the work done by the Board since its inception in November 1939. The principal function of this body constituted in accordance with the provisions of the Coal Mines Safety (Stowing) Act of 1939 passed by the Government of India is to administer a fund known as the Coal Mines Stowing Fund for meeting the expenses in connection with the administration and furtherance of the objects of the Act and with the grant of stowing materials and other assistance to owners, agents, or managers of coal mines. A brief account of the Jharia and Kusunda fires in February 1939 is given as an Appendix to the *Report* and is illustrated with several striking photographs (some in colour) of the fire areas, taken by Mr. V. P. Sondhi, of the Geological Survey of India. As the *Report* puts it, "no description in words can convey a clearer impression of the devastating activity of the fires than these photographic views".

Iron Ore Deposits of Bihar and Orissa.—Several questions arising out of a study of certain aspects of the formation and sequence of a group of rock strata known as the Iron Ore Series in the South Singhbhum area in Bihar have been clarified by Dr. J. A. Dunn, of the Geological Survey of India, in a brochure entitled "The Stratigraphy of South Singhbhum".

The publication deals mainly with the stratigraphical aspects of the area discussed but does not omit to touch upon the mineral deposits occurring therein. Dr. Dunn produces evidence to show that a regrouping of the area is necessary to distinguish the true Iron Ore Series occurring in the lower and older group of strata which contains the main iron ore deposits, from the relatively newer Kolhan Series occurring in the upper group of strata.

The upper or Kolhan Series comprises shales on top, limestones in the middle and sandstone conglomerates in the base which rest unconformably on the lower or real Iron Ore Series. The latter consist of phyllites, banded hematite-quartzites, tuffs, cherts and lavas. Dr. Dunn is, however, himself not quite satisfied that the detailed geological structure of the folded Iron Ore Series has been fully elucidated, but the change in sequence of the strata has led to a clearer understanding of the origin and distribution of the iron and manganese ore deposits.

In 1934 the Geological Survey of India issued a valuable contribution by Mr. H. Cecil Jones on "The Iron Ore Deposits of Bihar and Orissa" as a *Memoir*, Volume 63, Part 2. The brochure now issued is part 3 of that volume. Its author, Dr. Dunn had been early associated with Mr. Jones and has been long engaged on Geological investigations in Bihar and Orissa and is particularly qualified to deal with the subject.

Mysore Geological Department.—The latest number of the *Records of the Mysore Geological Department* (Vol. 38, 1939) begins with the Director's General Report for the year 1938–39 in which a detailed account is given of the administrative and scientific work done in the Department during the year. In connection with the scheme for the development of hydro-electric power at Jog, the Department made a detailed examination of the sites for the location of the Dam, Forebay, Penstock lines and Generating Station, and submitted the results to the Chief Electric Engineer. There are also a number of papers published in the *Records* embodying the work done by the officers of the Department mostly dealing with prospecting work for useful minerals like silica, asbestos, bauxite, etc., in the State. Special schemes for the preparation of chemical products such as sodium bichromate and potassium permanganate from the raw materials available in Mysore, are also under the active consideration of the Department.

Indian Central Jute Committee.—The importance of a technique which enables reliable spinning trials to be made on small samples of fibre, needs no emphasis. In work connected with the selection and breeding of improved strains of jute, the quantity of fibre available in the early stages of the development of a new variety is necessarily very small. To save the waste of time, labour and money which would be involved in carrying on the breeding of inferior varieties it is clearly desirable to be able to assess the quality of the fibre yielded by a new variety at the earliest possible stage. With this object in view the Technological Research Laboratories of the Indian Central Jute Committee have prepared a brochure describing the methods which have been worked out in the Laboratories for obtaining from small quantities of fibre a representative sample of yarn on which tests may be made that can be relied upon to give an indication of the quality of the fibre.

The brochure is called "Technological Research Memoir No. 1—A Technique for Spinning Yarn Samples from Small Quantities of Fibre". The technique described in this memoir is also adapted for comparing the effect on fibre quality of manurial treatments, soil conditions, rate of sowing, state of ripeness at which the jute is cut and so on. It is also suitable for purposes such as examining the results of variations in spinning procedure and batching treatment and for comparing the quality of the different positions of the fibre (top, middle and bottom). The method enables a spinning trial and yarn tests to be made if a quantity of fibre as small as 10 lb. is available, although for general purposes a rather greater quantity (20 to 40 lb.) is preferable. The technique involves no radical departure from mill practice, but calls for only certain minor modifications in it.

The Government of India have recently approved the scheme for the extension of the Technological Research Laboratory of the Indian Central Jute Committee for research work on the new uses of jute. For this purpose, they have provided, in the next year's budget,

a sum of Rs. 3,85,000 (non-recurring) and Rs. 10,000 to Rs. 40,000 (recurring). At its recent meeting held at Calcutta on 27–30 January, the Indian Central Jute Committee appointed a sub-committee of experts to recommend the equipment that would be required for the work.

At the same meeting, it was decided to carry out investigations on the use of jute sticks for preparing α-cellulose. Collaboration with the Forest Research Institute, Dehra Dun, was agreed upon for exploring the economic utilisation of jute waste in the manufacture of paper. A sub-committee consisting of Prof. M. N. Saha, F.R.S., Mr. C. R. Nodder and Dr. W. G. Macmillan was appointed to prepare a programme of research on the X-ray examination of jute.

Toxic Gases in Industry (The Detection of Organic Halide Compounds).—With the issue of No. 12—Organic Halogen Compounds (H.M. Stationery Office, price 2*d.*)—the Department of Scientific and Industrial Research completes its series of leaflets on methods for the detection of toxic gases in industry.

The wide use of organic halogen compounds as solvents and cleaning agents makes the occurrence of dangerous concentrations of the vapours possible in such industries as the artificial silk, bleaching and dyeing, dry cleaning, electro-plating, engineering, lithography rubber, etc. Ten of the commonest organic halogen compounds are dealt with, and the symptoms due to exposure to the vapours described. The effects are mainly narcotic, but tetrachloroethane, for example, is highly injurious to the liver.

The method of detection described is by the use of a form of blow lamp called the "Halide Detector Lamp" which burns pure alcohol in a supply of the air under test. The organic halide is decomposed, the corresponding copper halide is formed on a small copper screw in the nozzle of the lamp and, depending on the nature of the organic halide, the degree of green colouration in the flame indicates the concentration present. A table is given linking the appearance of the flame with concentrations of each of the ten halides. The exact procedure to be followed in using the lamp is described in the latter part of the leaflet. It must not be taken into an atmosphere containing inflammable vapours, and a special method of test is outlined for use when inflammable vapours are present.

Department of Chemical Technology, University of Bombay.—This progressive department of the University of Bombay is now issuing its annual report separately. Plans and estimates for new buildings for the Department at the rear of the Victoria Jubilee Technical Institute at Matunga have been approved by the Board of Visitors of the Department, the Syndicate and the Senate. The new buildings have been generously designed, with provision for future expansion, and special laboratories for micro-analysis, high pressure work, furnaces, air-conditioned tests, and an industrial museum. The Department has continued to maintain contact with the textile and other chemical industries of the Province, as evidenced by the employment of its graduates, the subsidies received for industrial research, and the increasing amount of analytical work and technical investigations submitted to the Department. A noteworthy feature is the provision of private endowments consisting of a Fellowship of Rs. 100 a month, and a subsidy of Rs. 100 per month to the Department towards the cost of materials, etc. The expenditure involved in the purchase or fabrication of any special equipment is also borne by the party concerned, whose sole property are the results of the investigation.

Manufacture of Fish Oils in India.—At the fourth meeting of the Medical Stores Supply Committee held in New Delhi on the 20th January, the Chairman, Lt.-General G. G. Jolly, Director-General, Indian Medical Service, revealed that a flourishing fish liver oil industry existed in the Madras Presidency eighty years ago. Apparently this flourishing concern was gradually killed by competition in prices.

Medicinal liver oil from the shark and saw-fish is once more being produced in Calicut. It is understood that efforts are also being made by the Governments of Bombay and Bengal and the State of Travancore to manufacture fish oils. Modern research has shown that the use of shark and saw-fish liver oils as a substitute for cod liver oil is sound practice, since the former are considerably richer in Vitamin A than cod liver oil.

A modern industry engaged in the production of medicinal fish liver oil enjoys the advantage that scientific methods for testing and standardising such oil are available. Investigations about the vitamin content of oil in the *Nutrition Research Laboratories*, Coonoor and other laboratories have played an important part in recent developments.

Manufacture of Paper in India.—The production of paper in India followed a steep rising trend during 1939–40. It amounted to 1,416,000 cwt. as compared with 1,184,000 cwt. in the preceding year and 1,076,000 cwt. in 1937–38. There were altogether thirteen mills in operation during the year.

The dislocation of trade with the Scandinavian countries and the consequent reduction in imports of paper gave the industry a respite from foreign competition and although costs of materials increased along with the prices of paper, the situation still left a substantial balance of advantage in favour of the industry.

Mechanical newsprint, which used to be imported mainly from the Scandinavian countries and which is not made in India, could still be obtained from alternative sources such as Canada and the United States of America, but there was a large variety of other papers including fine papers for which consumers have now to depend entirely on Indian mills. Some of them were never produced in India and it is possible that there may be a serious shortage of such varieties till Indian mills are able to produce suitable substitutes for them.

Imperial Agricultural Research Institute.—MR. P. L. CHATURVEDI has been awarded the Diploma of the Institute (Assoc. I.A.R.I.) after the completion of two-year post-graduate course in Entomology commencing from November 1938, and the acceptance, by the Institute Council, of his thesis under the title of "Biology of *Melanagromyza Phaseoli* Coq".

The appointment of **Prof. J. N. Ray** as Director of Production, Drugs and Dressings, has been gazetted. Laboratory facilities have been provided for him at the Imperial Agricultural Research Institute, New Delhi.

Royal Asiatic Society of Bengal.—At the annual meeting of the society held on 3rd February at Calcutta, the following gentlemen were elected office-bearers for the year 1941:—

President: The Hon'ble Mr. Justice Lort-Williams, KT., K.C.

Vice-Presidents: Bt.-Col. Sir R. N. Chopra, Dr. C. S. Fox, Dr. Syamaprasad Mookerjee and Sir S. Radhakrishnan.

General Secretary: Dr. B. S. Guha.

Treasurer: Dr. Baini Prashad.

The Sir William Jones Memorial Medal has been awarded to **Sir P. C. Ray** in appreciation of his researches in science. The award is made triennially out of an endowment fund created in 1926 by Sir U. N. Brahmachari in memory of Sir William Jones, the founder of the Society.

The Indian Botanical Society.—As a result of elections held at the Twentieth Annual Meeting of the Indian Botanical Society at Benares on the 3rd January 1941, the Executive Council was constituted as follows:—

President: Prof. S. L. Ghose (Lahore); *Vice-Presidents*: Dr. H. Chaudhuri (Lahore), and Dr. Shri Ranjan (Allahabad); *Secretary*: Prof. Y. Bharadwaja (Benares); *Treasurer*: Prof. M. O. P. Iyengar (Madras).

Elected Members of the Executive Council: Dr. P. L. Anand (Lahore), Dr. K. Biswas (Calcutta), Dr. Rafique A. Khan (Aligarh), Dr. B. C. Kundu (Calcutta), Rai Bahadur Prof. K. C. Mehta (Agra), Dr. R. L. Nirula (Nagpur), Dr. B. P. Pal (New Delhi), Principal P. Parija (Cuttack), Prof. B. Sahni (Lucknow) and Rai Sahib Kalidas Sawhney (Parbhani-Deccan).

University of Mysore, *January* 1941.—The results of the Medical Examination held in December 1940 were published. They were as follows:—

I. Examination:

		Examined	Passed
1.	Pre-medical	29	20
2.	First M.B.B.S.	30	17
3.	Second do. Pt. I	20	15
	Do. Pt. II	16	12
	Do. Pt. III	16	5
4.	Final M.B.B.S.	29	10

II. University Extension Lectures.—Dastur Dr. M. N. Dhalla, M.A., PH.D., LITT.D., High Priest of the Parsees of Karachi and Sind, delivered a lecture at Mysore on "Our Indo-Iranian Heritage".

The Hilger Abridged Spectrophotometer.—Leaflet SB. 289 (August 1940) of **Adam Hilger** Ltd., describes a simple instrument for approximate spectrophotometric analysis and for investigating colour differences. With a set of light filters mounted on a slide in the eye-piece, and a polarising lamina, a series of measurements can be made of the variation of reflection factor throughout the visible spectrum, thus providing valuable information as to the nature of any colouring matter, or of any discolouration, adulteration, or other quality of the material. The instrument is very suitable for carrying out rapid spectrophotometric tests of an explanatory character or for spectrophotometric measurements in which the highest accuracy is not essential. It is applicable to a variety of coloured materials such as Printing Inks, Textiles, Plastics, Prepared Foodstuffs, Paper and Leather Goods. For materials which are nearly white in colour, such as flour, chemicals and paper, an enhancement of the photometric sensitivity can be obtained by attaching to the 'Colour Comparator' a "Hilger Photometric Amplifier", which employs the principle of multiple reflection to increase the apparent selecetive absorption.

A New Photo-Electric Colorimeter.—The need for a really efficient Photo-electric Colorimeter has long been felt. The Klett Manufacturing Co., of New York, after years of research work, have placed in the market such an instrument in the name of Klett-Summerson Photo-electric Colorimeter.

The development of the Photo-electric Colorimeter provides the scientists with an inexpensive instrument to make colour determinations entirely by electrical methods.

The instrument is easy to operate. It is entirely self-contained and is run directly from the electric mains supply.

It is suitable for the determination of blood sugar, urea, creatinine, uric acid, vitamin C in blood, iron, copper, etc. Readings can be taken with as little as 5 c.c. of liquid.

Particulars are available from Messrs. **The Scientific Instrument Co. Ltd.**, 5A, Albert Road, Allahabad.

SEISMOLOGICAL NOTES

During the month of January 1941, five moderate and six slight earthquake shocks were recorded by the Colaba seismographs as against three moderate and three slight ones recorded during the same month in 1940. Details for January 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I.S.T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
1941		H.	M.	(Miles)		(Miles)	
January 2	Slight	22	20	3100			
4	Slight	08	43	3750			
6	Moderate	00	17	3420	Near 6° N., 123° E., to the South of the Philippine Islands		
10	Slight	13	08	1070			
11	Moderate	14	02	1930	Near 16°·5 N., 43°·5 E. in Yemen in Arabia		
12	Slight	15	47	870			
13	Moderate	21	58	5650	Near 0°·5 S., 154°·0 E., to the North of New Ireland		Damages to buildings reported in Por Rabaul in New Britain
21	Moderate	18	12	1350	Near 27°·5N., 92°·5E., to the North of Assam		Felt strongly at Shillong and mildly at Sylhet, Silchar and Gauhati
27	Moderate	08	00	1430	Near 28° N., 93° E., in Tibet to the North of Assam		
30	Slight	14	45	1480			
31	Slight	08	09	3910			

MAGNETIC NOTES

January 1941 was magnetically less disturbed than the previous month. There were 9 *quiet* days, 20 days of *slight* disturbance and 2 of *moderate* disturbance as against 4 quiet days, 21 days of slight disturbance, 4 of moderate disturbance and 2 of great disturbance during January 1940. The day of largest disturbance during January 1941 was the 17th when a moderate storm was in progress, while that of least disturbance was the 14th. Classification of individual days are shown below.

Quiet days	Disturbed days	
	Slight	Moderate
4, 11–15, 28, 29, 31.	1–3, 5–10, 18–27, 30.	16, 17

During the month one moderate magnetic storm was recorded as against four storms (two of moderate intensity and two of great intensity) during January last year. The monthly mean character figure for the month is 0·77 while that for January 1940 was 1·06.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Sun will be at the vernal equinox on March 21, 1941, at $5^h\ 30^m$ a.m. I.S.T.

Eclipses.—Two eclipses will occur during the month; one of them is a partial eclipse of the Moon on March 13, 1941. The ending alone will be visible in the eastern parts of India, the Moon leaving umbra at 6-26 p.m. The other is an annular eclipse of the Sun on March 27 and will be invisible in this country. The path of the annular eclipse begins in the Antarctic Ocean and crossing the Pacific Ocean ends in the middle of South America.

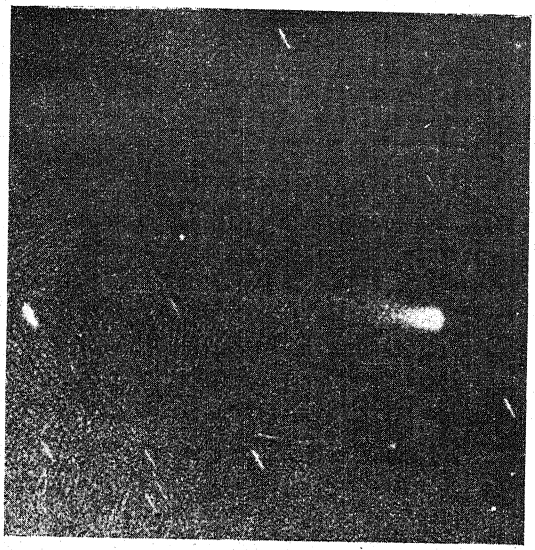
Planets during March 1941.—Mercury which will be visible as a morning star throughout the month, will be stationary on March 10 and will attain greatest elongation west of the Sun on March 25 when its angular distance is 28°W. Venus will be too near the Sun to be conveniently observed. Mars rises about a couple of hours after midnight and can be seen as a reddish star of the first magnitude in the constellation Sagittarius.

After conjunction on February 21, Jupiter and Saturn will be gradually separating from

each other and are still visible as bright objects in the western sky in the early part of the night. On the evening of March 3, the two planets will be in close conjunction with the Moon. Uranus continues to move slowly eastward in the constellation Taurus: and Neptune which is in opposition to the Sun on March 17 can be seen in the field of a small telescope very close to the star β Virginis (magnitude 3·7).

Comet Notes.—It is now several years since a comet sufficiently bright to be conspicuously visible to the naked eye, has made its appearance. About the end of last month, a fairly bright comet with a considerable tail was noticed in the south-western sky immediately after sunset; the object has been, since then, widely observed in India and Ceylon, and has attracted popular attention.

On February 4, the comet was about 5° south of the star β Ceti (magnitude 2·24) and has been moving rapidly in a north-easterly direction at the rate of two or three degrees per day. The tail appears to have been about 6° long at the end of last month and is slowly



Comet (1940 *d*)

Nizamiah Observatory :—Photograph taken with 4-inch astro-camera. 1941 February 7. Exposure 70 minutes. The telescope was driven to follow the comet and on account of its rapid motion during the exposure, the stars are shown as short trails on the photograph

diminishing in length; on February 11, it could be traced to a distance of two degrees. The comet is now receding from the Sun and becoming fainter, the magnitude according to an observation on February 10 was estimated to be between 5 and 6. It is likely to be visible for some days more with telescopes of moderate size.

T. P. B.

ANNOUNCEMENTS

Tuberculosis Association of India.—The Annual General Meeting of the Association will take place at the Viceroy's House, New Delhi, on the 25th March 1941, at 6 p.m. It will be open to the members of the Central Association.

Tin Research Institute.—Since October 1940, *The International Tin Research and Development Council* has changed its name to the *Tin Research Institute*. It continues to be controlled and supported by a committee representing tin producers in the Belgian Congo, Bolivia, French Indo-China, Malaya, the Netherlands East Indies, Nigeria and Thailand. The well-known quarterly review which gives scientific and technical information relating to the production and uses of tin, its alloys, and chemical compounds, are being issued by the *Tin Research Institute*.

We acknowledge with thanks the receipt of the following:—

"Journal of Agricultural Research," Vol. 61, Nos. 1–2.

"Indian Journal of Agricultural Science," Vol. 10, Pt. 6.

"Journal of the Annamalai University," Vol. 10, No. 2.

"Journal of Chemical Physics," Vol. 8, No. 12.

"Journal of the Indian Chemical Society," Vol. 17, No. 10.

"Comptes Rendus (Doklady)," Vol. 27, Nos. 5–6.

"Experiment Station Record", Vol. 83, No. 5.

"Indian Forester," Vol. 67, No. 2.

"Indian Farming," Vol. 2, No. 1.

"Indian Central Jute Committee (Bulletin)," Vol. 3, No. 10.

"Review of Applied Mycology," Vol. 19, Pt. 11.

"Journal of Nutrition," Vol. 20, No. 6.

"Journal of the American Museum of Natural History," Vol. 46, No. 5.

"Journal of Research" (National Bureau of Standards), Vol. 25, Nos. 4–5.

"Sky," Vol. 5, No. 3.

"Science and Culture," Vol. 6, No. 8.

"Indian Trade Journal," Vol. 140, Nos. 1804–1807.

"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 10, Pt. 4.

BOOKS

1. "The Ring Index" by Austin M. Patterson and Leonard T. Capell. (Reinhold Publishing Co., N.Y.)

2. "A Text-book of Sound for B.Sc. Students" by R. N. Ghosh and R. N. Rai. (Indian Press, Ltd., Allahabad.)

3. "The Biochemistry of Symbiotic Nitrogen Fixation" by Perry W. Wilson. (University of Wisconsin Press.)

ACADEMIES AND SOCIETIES

Indian Academy of Sciences (Proceedings)

January 1941, SECTION A.—SIR C. V. RAMAN: *Crystals and photons.* The incident radiation excites the crystal vibrations of which the phases are everywhere in coherent relationship with the phase of the radiation field. The scattering of light or the reflection of X-rays with change of frequency appears as the result of the phase of the lattice vibrations varying from point to point in such a manner that the crystal is, in effect, an optically stratified medium giving a monochromatic reflection of the incident rays at the appropriate angle of incidence determined by the spacing of the stratifications and the wave-length of the incident radiation. H. J. BHABHA AND B. S. MADHAVA RAO: *The scattering of charged mesons.* On the basis of the assumption put forward by Bhabha that the heavy particles can exist in states of all integral charge, it is shown that the scattering of charged mesons completely corresponds with the classical theory. B. D. SAKSENA: *Raman spectrum of gypsum.* The polarisation studies and the results obtained with polarised incident light completely satisfy the selection rules for a monoclinic crystal. R. D. DESAI, ABDUL HAMID AND H. P. SHROFF: *Studies in naphthalene series. Part VI. Synthesis of 2-propyl-1-naphthol and properties of 2-propionyl-1-naphthol.* R. D. DESAI AND W. S. WARAVDEKAR: *Studies in naphthalene series. Part VII. Attempted synthesis of 4-stearyl-, 4-palmityl-, and 4-lauryl-1-naphthols.* B. KRISHNASWAMY AND T. R. SESHADRI: *Synthetic experiments in the benzo-pyrone series. Part III. Syntheses of coumarino- and flavono-a-methyl-7 : 8-dihydrofurans.* A fresh method for building up furan rings on to coumarin and flavone compounds has been studied. (LATE) N. W. HIRWE AND P. Y. KULKARNI: *Studies in chloral amides—Part VII.* S. PARAMASIVAN: *Electrolytic restoration of bronze statues and inscribed copper-plates.* K. VENKATESWARLU: *Relative intensities of Stokes and anti-Stokes Raman lines in crystals.* MISS IONE N. D. DASS AND J. D. TEWARI: *The effect of unsaturated chromophores on pyronine dyestuffs. Part II. Dyes obtained from maleic and succinic acids.* GURDAS RAM AND V. I. VAIDHIANATHAN: *On capillary forces in natural soils.* The capillary theory of a bundle of tubes cannot apply to natural soils and conclusions derived from such a consideration must be wrong. HANSRAJ GUPTA: *An important congruence.*

SECTION B.—SIR C. V. RAMAN: *Crystals and photons.* N. KRISHNASWAMY AND G. N. RANGASWAMI AYYANGAR: *An autotriploid in the pearl millet* (Pennisetum typhoides *S. and H!*). T. S. RAGHAVAN AND V. K. SRINIVASAN: *Morphological and cytological studies in the scrophulariaceæ. III. A contribution to the life-history of* Ilysanthes parviflora *Benth.* JOSE PEREIRA: *On a trypanosome found in the blood of* Urolocha striata *L.* T. PRASANNASIMHA ROW: *The range of variation of normal eye tension and the relation between blood pressure and eye tension.* A. ANANTHANARAYANA AYER: *Facial musculature of semnopithecus entellus.* T. S. RAMAKRISHNAN: *Studies in the genus Colletotrichum. 1. Saltation in* Colletotrichum capsici (*Syd.*). S. N. DAS GUPTA, G. S. VERMA AND S. SINHA: *Studies in the diseases of* Mangifera indica *Linn. Part III. Investigation into the effect of sulphur dioxide gas on the mango fruit.*

Indian Chemical Society: (*Journal*)

October 1940.—K. V. VIJAYARAGHAVAN: *Mercury diallyl and allyl mercuric halides.* (MISS) ASIMA MOOKERJEE: *On the bitter principles of* Citrus decumana. S. M. SETHNA AND R. C. SHAH: *Kostanecki-Robinson Reaction—Part III. Benzoylation of Orcacetophenone and its monomethyl ether.* MAHAN SINGH AND ARJAN SINGH: *Magnetic susceptibility and optical rotatory powers of p-hydroxy-a-naphthyliminocamphor.* PHANINDRA CHANDRA DUTTA: *A new synthesis of hexahydro-isophthalic acid.* PHANINDRA CHANDRA DUTTA: *Studies in the cyclopentane series—Part I. Synthesis of 1-methylcyclopentane-1 : 2-dicarboxylic acid in cis- and trans-forms.* K. N. GAIND. J. N. RAY AND BADRI SARIN: *Synthesis of new local anæsthetics—Part V.* PRODOSH CHANDRA RAY-CHOUDHURY: *Complex chromium selenates.* SRIDHAR SARVOTTAM JOSHI AND DUSHYANT NARASINGASA SOLANKI: *The influence of temperature on the electrical conductivity and viscosity of aqueous mercuric chloride.*

Geological Institute, Calcutta: (*Journal*)

The recent number (Vol. III) of the Journal *Bhu-Vidya* of the Geological Institute, Presidency College, Calcutta, contains a number of articles of varied interest such as the Economic Deposits of Bengal (by S. C. Guha), Marine Transgressions (by S. K. Ray), An Abandoned Gold Mine in S.E. Wynaad (by J. Sen Gupta), etc. The Journal also gives a Report of the several activities of the Institute during 1939–40 under the Presidentship of Dr. P. K. Ghosh, of the Geological Survey of India.

ERRATA

1. *Vol.* 9, *No.* 12, *December* 1940: Contribution entitled, "Tetraploid Til (*Sesamum orientale* L.) from Colchicine Treatment", page 542; legend under Fig. 1, *for* "Deploid Sesam" *read* "Diploid Sesame"; under Fig. 2, *for* "Tetraploid Sesam" *read* "Tetraploid Sesame".
2. *Vol.* 10, *No.* 1, *January* 1941: Note entitled "Production of Fruit-bodies of *Agariceus polyporus* Berk. in Artificial Culture", page 26, 2nd column in the heading of the note *for "Agariceus polyporus* Berk." *read "Polyporus agariceous* Berk."; line 20 of the same note *for* "Polyporus culture" *read* "Polysporus culture".

SUPPLEMENT TO CURRENT SCIENCE

Vol. X] FEBRUARY 1941 [No. 2

ORGANIZATION OF PUBLIC HEALTH AND MEDICAL SERVICE IN INDIA*

BY

BREVET-COL. SIR R. N. CHOPRA

DURING the early times there was a relatively highly evolved system of curative medicine in vogue throughout India. This was particularly well developed during the heyday of Buddhism in the country, but the highly important preventive side was, as in almost all other countries during this period, non-existent. Contact with the West marked a material change, and one of the outstanding points of this change was that with the exception of a relatively small number of private practitioners of the indigenous systems of medicine, the State assumed almost the entire responsibility for providing medical relief to the country. Hospitals, dispensaries and other adjuncts, together with the necessary personnel, were provided on a fairly liberal scale, but these were far from sufficient for the teeming millions of this great land. Further, in essentials all this provision concerned itself for a long time with the curative rather than the preventive side of medical relief. Within recent years in a few of the larger towns some public-spirited people or communities have provided additional institutions of curative medicine, while the numbers of private practitioners have also materially increased. All the same, the present position is far from satisfactory, and in view of the impending constitutional changes it is proposed in this communication to take stock of the situation and suggest what should be done for improving the existing conditions.

In a review of the Public Health Administration in India at least three landmarks in the history of its development have to be considered[1]:—

(i) The appointment of a Royal Commission to enquire into the health of the army in India in 1859. (ii) The report of the Plague Commission in 1904 following the outbreak of plague in 1896. (iii) The Reforms introduced by the Government of India Act of 1919.

The Royal Commission of 1859 was appointed to enquire into the extremely unsatisfactory conditions of the health of the army in the country. Between 1859 and 1863, the mortality rate among European troops was 69 per 1,000, while among European women in 'married quarters' it varied from 44 to 276 per 1,000. The Royal Commission recommended measures not only for the army but also for the civilian population. In accordance with its suggestions 'Commissions of Public Health' were established in Madras, Bombay and Bengal in 1864. The Commissions in Madras and Bengal, though they advocated far-reaching measures including the employment of trained public health staffs in the districts, did not lay down any definite policy. In the words of a former Sanitary Commissioner with the Government of India, 'Government had to deal with a population which was unwilling and unready to receive sanitation, which either frankly disbelieved in its efficacy and resented any change in established

* From the Presidential Address delivered at the Annual Meeting of the National Institute of Sciences of India, held on the 2nd January 1941, at the Benares Hindu University.

[1] Ref. Raja, K.C.K.E., *Ind. Med. Gaz.*, July 1937.

customs or was too ignorant and apathetic to understand the goal at which it aimed. Sanitary measures were received not only by indifference but by active opposition.' Under the circumstances, very little advance was possible, but the outbreak of plague in 1896 raised issues of fundamental importance which can best be summed up in the words of the Sanitary Commissioner at that time:—

'When plague appeared it was not a new disease, but it was new to the present generation of Indians and it has exacted a very heavy toll of deaths all over the country. The strangeness of the disease, the unpopularity of the measures taken to control it and the importance of these measures have served to rouse the people from their apathy and concentrate the attention of all, but especially of the educated classes, on sanitation in a way that nothing else could have done.

'At the same time plague has not been without its effect on Government. Previous to the advent of this disease it had been the generally accepted opinion that sanitation was the work of any medical officer and required no special training. A special sanitary staff had, therefore, not been considered of any very great importance. When plague appeared the staff was inadequate and unprepared; action was taken on general principles and sanitary measures were adopted, which, with further study of the ætiology, we now know were unsuitable and could do little to check the spread of the disease. The waste of life, time, money and effort that resulted has impressed on Government the necessity of being prepared in future and large changes have been effected with that object.'

The report of the Plague Commission in 1904 advocated the reconstruction of the Sanitary Department on a wide imperial basis, with the provision of adequate laboratory accommodation for research, teaching and the production of sera and vaccines. The Indian Research Fund Association was formed in 1911 and a forward sanitary policy, with a devolution of powers to the local governments, was formulated in a resolution of the Government of India in 1914.

The Montague-Chelmsford Reforms of 1919 had a very marked effect on Public Health Administration; this was partly beneficial and in other respects detrimental. Provincial ministers responsible to the legislature were anxious to hasten the growth of education, medical relief and sanitation so far as funds permitted. The organization of trained Public Health staffs for urban and rural areas, which the 'Commissions of Public Health' had recommended in the sixties of the last century, was at last taken up in earnest and in the years succeeding the introduction of the Reforms, the organization of health services became a marked feature in most Provinces. Since 1921 there has indeed been far greater public health activity in the Provinces than ever before.

All Civil Medical Services in Presidencies and Provinces were formerly under the control of a single administrative officer known as the Surgeon-General in the former and the Inspector-General of Civil Hospitals in the latter. Unfortunately, owing to an insistent demand for medical relief, which is what appeals most to the individual in a community with a relatively low standard of living, the available funds were expended in the main on increasing and improving hospitals and dispensaries, and the obvious need for more and yet more of these, associated with a chronic shortage of funds led to the neglect of preventive measures and particularly of those fundamental but costly ones comprised in the term 'Environmental Hygiene'. Relief of sickness and suffering was readily understood and appreciated by the public, while the application of sanitary measures, implying as it did interference in age-long habits, with restrictions which were regarded as irksome and trespassing upon vested interests or religious customs, was opposed on all hands by the people who are as conservative as any in the world. *En passant* it may be noted that the position in India at this time was generally very similar to that in England some hundred years ago.

Early in the present century the Secretary of State for India caused the separation of preventive from curative medicine by creating in each Presidency and Province a separate 'department' for preventive medicine, with an independent budget, and under an officer designated as the 'Sanitary Commissioner'; the name of the officer was changed in 1922 to the less appropriate one of 'Director of Public Health', and his department was also designated as the 'Public Health Department'. In many Provinces the division of duties as between the heads of the departments of curative and preventive medicine was not fully specified, and only a broad distinction of curative and preventive medicine was regarded as sufficient. The formation of separate departments for preventive medicine in the various Provinces provided a great impetus for this branch of medical

work, and far-reaching, much needed reforms were planned. These in many cases were well advanced when the Great War (1914–18) called a halt for the time being. After the war the young Public Health Department again got busy. They found themselves faced with the immense problem of Environmental Hygiene in a land where, even in towns, safe water supply and sanitary systems of sewage and rubbish disposal were, as a rule, conspicuous by their absence, the housing of the poorer classes was atrocious, and local administration, except in a few outstanding cases, was overshadowed by vested interests and correspondingly inefficient. In the rural areas sanitation simply did not exist, soil pollution was general, flies swarmed, malaria and hookworm infection were almost universal, leprosy and tuberculosis were widespread and smallpox, cholera and plague regularly took their periodic tolls uncontrolled by any environmental checks or preventive measures. The provision of properly qualified and trained staff for this work presented a serious difficulty. The Medical Department had its system of hospitals and dispensaries manned by Civil Surgeons, Assistant Surgeons, and Sub-Assistant Surgeons. In some Provinces the Civil Surgeons, originally *ex-officio* District Medical and Sanitary Officers, retained the dual charge, while the Public Health Department was building up a subordinate personnel of Sanitary Inspectors, epidemic Sub-Assistant Surgeons or Health Assistants to Civil Surgeons and later Health Visitors. All these worked under the Director of Public Health who had one or more Assistant Directors and other specialists, leaving the provision of the more costly full-time District Health Officers until the subordinate personnel had been trained and appointed. Other Provinces hastily appointed expensive District Sanitary Officers, whom in some cases they called Medical Officers of Health, although, owing to the fact that every district already had a District Medical Officer or the 'Civil Surgeon' as he is usually called throughout India, their duties were not comparable with those of Medical Officers of Health in England. Further, in the absence of a separate staff of subordinates the work of these new officers was limited to advising only. As an exception, however, the Presidency of Madras succeeded in creating a complete staff of Health Officers, Assistant Officers and Sanitary Inspectors.

The question at the present time is the lack of co-operation and consequently of co-ordination obtaining in many parts of India between the official Medical and Public Health Departments.[2] This is a problem peculiar to India, for it does not exist in Western countries nor in the Dominions and Colonies where the separation of the official Health Services into 'curative' and 'preventive' sections has never been effected. To some extent this is due to the unsuitable titles given to the respective Departments and still more to their administrative heads. In the Presidencies the head of the Medical Department, as has been remarked already, is known as the 'Surgeon-General': a passable appellation with an historical basis as it is applied to the Chief of the United States Public Health Service. In the Provinces, on the other hand, the head of the Medical Services is known as the 'Inspector-General of Civil Hospitals': an inadequate and misleading designation for one who is the adviser to Government on all matters connected with medical relief, administrator of all public medical institutions, head of the medical services in the Province, President of the Provincial Medical Council of Registration and Medical Education and President or Chairman of a host of other medical organizations and committees. The designation 'Director of Public Health' is equally inappropriate, since it implies extensive powers and a range of activities much wider than are possible under existing conditions. The two titles together are largely responsible for the confusion of functions pertaining to the two Departments and the consequent overlapping, duplication and wastage of their resources. Another factor contributing to this confusion has been the absence of orders laying down the exact policy and scope of work for each Department.

It has been asserted that the maintenance of separate departments for medical relief and preventive medicine is an advance upon the English System. Its advocates point out that it enables experts on each side to administer their own subjects. While the specialists in preventive medicine argue that those who have not taken a diploma in Public Health cannot appreciate the requirements and scope of their work, they seem to lose sight of the fact that Public Health personnel is so fully occupied with Environmental Hygiene that it loses all touch with clinical work and is, therefore, not the proper agency for the administration of medical relief. There is much to be said on both sides. Even in England similar views have been expressed by recognized leaders of the profession. But in actual practice the maintenance

[2] Ref. Jolly, G. G., *Ind. Med. Gaz.*, April 1940.

of two separate public medical services has not led to satisfactory results in India. So long as the Public Health Department limited its activities to Environmental Hygiene there was little or no difficulty. This subject offers so vast a field that it could well keep a large department fully occupied for many decades to come. As soon, however, as the separate Public Health Department proceeded to interest itself in individuals rather than communities, overlapping began to appear; this has been most marked in the fields of maternity and child welfare, leprosy and tuberculosis, and even rural medical relief. In regard to midwifery a tendency appears to be developing which, if it is not checked may lead to a conflict between the practising doctors and health visitors and midwives. Already with the peculiar social conditions prevailing in this country medical colleges and schools are finding it increasingly difficult to obtain the requisite number of 'cases' for training. The position in regard to such diseases as leprosy and tuberculosis is anomalous. In one Province the Inspector-General of Civil Hospitals is responsible for leprosy work, in another the Director of Public Health. The same is the case with tuberculosis.

There is sufficient evidence, where it occurs, of a lack of co-operation between the two official departments and of the development of 'exclusion' instead of an *esprit de corps* which can only be destructive in its effects. The situation requires to be met by a close *liaison* between the two branches, such as, for example, obtains in the Government of India, where the Director-General, Indian Medical Service, has the Public Health Commissioner working with him in his office as his principal staff colleague. Such an arrangement not only conduces to a close co-operation, but the distribution of work is facilitated. The urgent necessity for a friendly collaboration between the two departments, if the system is not to break down, is essential, and is recognized by experienced administrative officers of both departments. The Central Advisory Board of Health established in 1937, should prove a valuable agency in this direction. At its meeting in Madras in January 1939, it passed the following resolution for the establishment of similar Provincial Boards of Health:

> 'The Board stresses the desirability of establishing in each Province and State an Advisory Board of Health with the Minister-in-charge as Chairman.'

While in reference to Maternity and Child Welfare it adopted the following resolution:

> 'Co-ordination between the medical and public health departments is perhaps more vital in the field of Maternity and Child Welfare than in any other of medical and public health work.'

If a policy of close friendly collaboration obtains between the two departments in the Provinces and the relative spheres of each are defined, the existing system will continue to function tolerably well, but if friendly co-operation that should be sought and loyally observed by the workers in both the departments is replaced by a spirit of exclusion, and co-operation is stigmatized as a 'dual control', then a position in which the two departments are in opposition will arise sooner or later and the profession will be divided into two camps. Such a state of affairs will hardly be in the interest of either of the two departments, while the effects of such a controversy are bound to lead to a great deal of suffering for the poor public.

The best solution of the problem appears to be the establishment of Ministers of Health in various Provinces modelled on the English System with suitable modifications in regard to the local conditions.

The modern Public Health Service in England is barely a quarter of a century old and, like so many of the English institutions it arose more by accident than by design. The dissolution of the monasteries left the destitute without any visible means of support until the year 1601, when the Elizabethan Poor Law established Parish Overseers and Workhouses; this system remained practically unchanged for over two centuries. Besides relieving destitution, these authorities carried out any measures that were necessary for the public health, such as the control of epidemics, the provision of sewers, or the abatement of sanitary nuisances. In 1834 the Poor Law Amendment Act was passed after a great deal of agitation and following the Report of the Poor Law Commission of 1832. This important Bill amalgamated the separate Parishes into Unions under the control of Boards of Guardians. District Medical Officers were appointed to attend to the sick poor, while the infirmaries were built to accommodate paupers who were too ill to be kept in the Workhouses. In 1835 the Municipal Corporations Act was placed on Statute Book to reform the chaotic state of the Borough Government.

Despite all these changes, the state of the public health was never taken very seriously until the cholera epidemics between 1830 and

1854 galvanized the Government into action. Edwin Chadwick, one of the Poor Law Commissioners, in his *Survey into the Sanitary Condition of the Labouring Classes of Great Britain*, exposed not only the insanitary evils of the towns and villages, the hideous legacy of the Industrial Revolution, but, by showing how closely disease was related to poverty, provided a convincing argument in favour of far-reaching reforms. His 'sanitary idea' led to the appointment in 1848 of the General Board of Health, which, after a stormy life, was superseded by the Local Government Board of 1871. In 1872 the country was divided into urban and sanitary districts, and medical officers of health and inspectors of nuisances were appointed for the first time. Credit is due to the authorities of the Liverpool Borough for having had the vision to appoint a Medical Officer of Health much earlier. Then followed the great Public Health Act of 1875 which is the bulwark of all sanitary laws.

A further Municipal Corporation Act was passed in 1882, while the year 1888 was conspicuous for the creation of County Councils and County Borough Councils. From this time onwards there has been an ever widening stream of health legislation. Statute after statute has swollen the ranks of the Public Health Service to such an extent that to-day there is scarcely any field of human activity in which the health officer does not play an important part. Another important landmark, the National Health Insurance Act of 1911, provided the adult manual worker with compulsory insurance against loss of health. The Bill was hotly contested during its passage through Parliament, but it was successfully piloted and passed into law through the efforts of Mr. Lloyd George.

Finally, the creation of a Ministry of Health in 1919 in place of the Local Government Board was the crowning recognition of the importance of health in the nation's life. This wise step was made inevitable by the Great War of 1914–18.

The general powers and duties of the Minister in relation to health are defined in the second clause of the *Ministry of Health Act*, 1919, as follows: To take all such steps as may be desirable to secure the preparation, effective carrying out and co-ordination of measures conducive to the health of the people, including measures for the prevention and cure of diseases, the avoidance of fraud in connection with alleged remedies therefor, the treatment of physical and mental defects, the treatment and care of the blind, the initiation and direction of research, the collection, preparation, publication and dissemination of information and statistics relating thereto, and the training of persons for health services.

Ministry of Health: The Ministry of Health is the chief tribunal for Local Authorities. Broadly, it engages in the following activities:—

(1) Public Health. (2) Local Government and Local Finance. (3) Housing and Town Planning. (4) Poor Law Administration. (5) National Health Insurance.

'Power', remarked John Stuart Mill, 'may be localized, but knowledge to be most useful must be centralized'. Thus, while most executive functions are passed over to the Local Authorities, the Ministry seeks to maintain proper standards of efficiency amongst them. It supervises their methods of government, especially in regard to the public health matters. Certain too forward authorities have to be restrained, while other backward ones have to be spurred on to better achievement. One of its most important functions is the control of local expenditure by sanctioning loans after careful inquiry.

Its Medical Department, under the Chief Medical Officer, is divided up into the following sections:—

(1) Medical Intelligence, Infectious Diseases, International Health, etc.

(2) Maternity and Child Welfare.

(3) Tuberculosis, Venereal Disease and Institutional Therapy.

(4) Nutrition, Food and Drugs Administration, London Hospitals, Water Supplies, etc.

(5) General Practitioner Services and Insurance.

(6) Surveys, Hospitals, Environmental Hygiene, and Public Assistance.

(7) Medical Services, Emergency Hospital.

(8) Welsh Board of Health.

Each of these Divisions is in charge of a Senior Medical Officer who is responsible to the Chief Medical Officer for the work carried on in his division. Furthermore, Regional Medical Officers are employed to supervise the work of the panel doctors and the pharmaceutical chemists under the National Health Insurance Scheme, while other officers are detailed to investigate serious epidemics of infectious diseases, outbreaks of food-poisoning, or make surveys of Local Government areas. These surveys are extremely valuable. Not only do they provide comparative indices to enable the

Ministry to issue reports, circulars, and memoranda for the information and guidance of Local Authorities, but, incidentally, they help the Medical Officer of Health to overcome some of the more difficult problems of administration.

Proposed Federal Ministry of Health of the Government of India

In India a Federal Ministry of Health should be established at the centre to provide the necessary co-operation agency for the provincial local self-government departments, which are at present responsible for the supervision of local bodies and for public health administration in the provinces. This Ministry would also be responsible for the other health functions statutorily conferred on the Central Government by the Government of India Act of 1935. All problems in connection with curative and preventive medicine should be dealt with by one department divided into appropriate sections. The following sections are tentatively suggested for consideration:—

1. Prison medical service.
2. Port sanitation and quarantine service.
3. School medical service.
4. Public Health including:—
   (*a*) Medical intelligence, infectious diseases and international health.
   (*b*) Nutrition, Food and Drugs administration including biological products.
   (*c*) Environmental Hygiene including housing, water supply, drainage, waste products.
   (*d*) Industrial hygiene.
5. Medical relief including:—
   (*a*) Maternity and Child Welfare, venereal diseases, tuberculosis, leprosy.
   (*b*) General practitioner services with special reference to rural dispensaries.
   (*c*) Hospitals.
   (*d*) Drug addiction.
   (*e*) Health Insurance.
6. Lunacy.
7. Scientific Research.

For these purposes, the Ministry should have a highly trained staff of expert advisers. The Director-General, Indian Medical Service, who as the Surgeon-General with the Government of India most nearly corresponds to the Chief Medical Officer of the Ministry of Health in England, has at present an insignificant number of specialists on his staff. In England though public health administration is established on well-regulated lines, the Chief Medical Officer controls a strong team of workers in each special subject of medical health work, such as maternity and child welfare, tuberculosis, industrial hygiene and so on. In India, on the other hand, while the conditions are much more complex, and although the necessity for an expansion of the Central Government's technical staff has been repeatedly stressed by the Directors-General and Public Health Commissioners, the task is left to only two or three officers.

The materials for the establishment of a Ministry of Health at the centre in India are all available. Thus, though many of the bureaux are under private bodies, their directors act as advisers to the Director-General, Indian Medical Service, who, as a rule, is connected with such bodies as the Chairman of their Managing Committees. Thus with the Director-General at the top we have roughly:—

1. Public Health Commissioner: Bureau of Quarantine, Infectious Diseases and International Health.
2. Deputy Director-General: Personnel and Establishment, Medical Relief, Medical Education, etc.
3. Assistant Director-General (Stores): Medical Supplies.
4. Maternity and Child Welfare Bureau of the Indian Red Cross Society. The Director-General is the Chairman of the Bureau.
5. Medical Commissioner of the Tuberculosis Association of India. The Director-General is the Chairman of this Association.
6. Medical Research. The Director-General is head of the Medical Research Department and Chairman of the Scientific Advisory Board, Indian Research Fund Association, while the Public Health Commissioner acts as its Secretary.
7. Drugs Control. The Director-General has the Director of Drug Control Laboratories on his staff, and he is also the Chairman of the Advisory Board for Drug Control.
8. Nutrition. The Director of Nutrition Research Institute as the officer-in-charge of the Nutrition Enquiries of the Indian Research Fund Association, acts as the expert adviser to the Director-General.
9. Malaria. The Director of the Malaria Institute of India acts as the adviser to the Director-General.

Other loose connections exist or are being forged, *e.g.*, Leprosy through B.E.L.R.A.: food standards through a standing committee to be set up by the Advisory Board of Health, while new connections have to be established with the Railway Medical Services, Prison Medical Services, School Medical Services, etc.

The provision of a suitable staff of experts must devolve on the Federal Government and cannot be relegated to the provinces. The Royal Commission on Health in Australia (1925) emphasized that, as 'the success of health administration is more dependent on the personality and capability of the officers directing it than on any other single factor, the Commonwealth Government should be responsible for the maintenance of highly trained experts to advise and help local authorities when desired by State Health Administrations'. If such an arrangement has succeeded in Australia, I agree with Raja (1937) that a similar plan might be equally successful in India. Moreover, a carefully selected central staff would, to some extent, avoid the duplication of posts of highly specialized men in the component States of the Federation, while the position and prestige of the Federal Administration should enable it to attract the proper type of men.

The selection of the Federal Chief Medical Officer should, however, be dependent on his having both Medical and Public Health experience, and his deputies must be given a chance to familiarize themselves with the wide range of the curative, preventive and constructive aspects of medicine in the country.

Each province should have a Chief Medical Officer responsible to the Minister of Health of the province for the administration of the whole of the Medical subject with a number of deputies in charge of the various departments, *e.g.*, prisons, schools, medical and public health problems. The deputies should be given a chance to work in different departments so that the Chief Medical Officer of the future would have men available with first hand experience of individual and Environmental Hygiene, while Regional Medical Officers should be appointed to look after various areas or zones.

A Provincial Board of Health under the Chairmanship of the Minister of Health should be constituted in each province. The members should be drawn from the Medical and Public Health specialists and suitable persons should be co-opted for different problems. The help of the Revenue, Education and Public Works Departments would be needed to shape the health policy of the Provinces. Suitable persons may be constituted into *ad hoc* committees to tackle important problems of general and local interest, while the co-operation and advice of the specialists on the staff of the Federal Ministry of Health should be available to the Provincial Governments in connection with problems of an all-India nature.

In the districts, District Health Committees should be formed for the same purpose. These should be presided over by the Collector of the district or the President of the District Board; the co-operation of both agencies is essential, and this alone will make it possible for these committees to work efficiently.

So far as the rural population is concerned, medical men engaged in curative work should be able to undertake public health duties as well. Their education and training should be of such a nature as to enable them to do so without difficulty. The doctors engaged in combating epidemic diseases should be expected to undertake public health work when not dealing with outbreaks of infectious diseases. The rural doctor, who is the final link between the Health Services in this country and the people, should also be responsible for giving an elementary health education to the patients in connection with their immediate surroundings. Such instruction would be much more effective than general lectures and demonstrations to large audiences.

Conclusions

To sum up the views expressed above, I consider that, under the conditions prevailing in India at present, the State is essentially responsible for providing the necessary agencies for both preventive and curative medicine. Curative medicine forms an integral part of the public health services of a country inasmuch as very often the sick man is the source of infection and no constructive medicine is possible unless the population is rendered free from disease by treating the individuals. Again, according to the newer conceptions of a State, it is necessary that disablement whether temporary or permanent should through intensive use of curative medicine be cut down to the barest minimum. Moreover, it is through curative medicine alone that it is possible to win the confidence of the public in a country like India and bring home to the people the advantages accruing both from preventive and constructive medicine.

Starting from the bottom, I consider that to meet the requirements of public health of the

population there should be a combined establishment which should form the basis of preventive, curative and constructive medicine in each village. This should be linked up with a more organized central agency discharging these combined duties and catering for a convenient sized population, the bulk of which will depend upon various factors such as communications, incidence of disease, etc. These primary organized centres will have to be supervised and assisted by a district centre in which there should be a specialized staff for the main medical subjects. These district centres in turn should be in touch with a larger provincial organization in which the staff consisting of specialists in various branches of medical science should work under a senior and experienced medical man. This latter should constitute the administrative head of the medical service in the province under the Provincial Ministry of Public Health. He should have a thorough training in the methods of public health administration, community health organization, constructive medicine, etc. The staff of the provincial organization should further be large enough to be utilized for medical and public health training both for under-graduate and post-graduate work.

The activities of the health organization in different provinces should be co-ordinated by a more elaborate and efficient Federal or an All-India organization working under the Federal Ministry of Health. The administrative head should be an officer with wide experience of preventive, curative and constructive medicine, and have on his staff expert advisers in as many of the important branches of medicine as possible. With the advice and help of these advisers, it should be his duty to deal with and co-ordinate the problems of public health which concern the country as a whole. Curative and preventive medicine must work as one single whole; to let them work separately in water-tight compartments is sure to lead to confusion, while only an organization of the nature detailed above will be able to deal successfully with the multifarious problems of public health in this vast country.

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THE CO-ORDINATION OF ROAD AND RAIL TRANSPORT

THE recent announcement of the surplus Railway Budget by the Communications Member must, no doubt, have come to the public as a very welcome departure from the somewhat unpleasant reading which previous Railway Budget speeches have provided. The impressive surplus of over 14 crores, which, as the Railway Member has confessed, surpasses all official estimates. This, however, should not lead us to complacency. It is a matter of common knowledge that this windfall for railway revenues is the direct result of the Railway Board's policy of upward revision of railway rates and fares announced last year, and the unprecedentedly heavy military traffic that is being moved by the railways. The railways themselves cannot claim much for any increased efficiency that might become apparent by a close scrutiny of railway operation. It is, therefore, clear that the public, as much as the railways themselves, must be on their guard against any over-optimism, as the conditions, under which such huge incomes are being earned, are abnormal and are bound to give way, in their turn, to less favourable circumstances.

War conditions, under which the railways of the British Empire are operating, have brought on many fresh problems, and have emphasised the importance of some of the old ones. The recent enquiries conducted by expert committees into the problems of wagon turn round, dearness allowances for railway workers, etc., are evidences of this. Among such problems one of the most important is the co-ordination of road and railway transport (the need for which was

recently voiced by Mr. Scot in the legislature), so as to produce an integrated scheme of services, capable of giving the cheapest and most efficiently organised means of transport to the community as a whole. In Great Britain, where the railways and road services are operating "under fire", the problems arising out of road-rail competition have, at least temporarily, been relegated to the background. In India, where uneconomic competition is very rife, the importance of this problem needs no emphasising.

Historically the growth of road-rail competition was, at least in part, due to the last World War. In England during the pre-war days competition in transport was mainly between the railways themselves. This competition has almost disappeared after the amalgamation of 1923, and the various pooling arrangements that came into force since then. After the demobilisation following the peace treaty a large number of military lorries were rendered superfluous to the Army and became available for sale at reduced prices. Many of the demobilised men, who had learnt to handle lorries during the period of national service, turned to the plying of motor lorries for hire, or reward as a profession, and this brought them into direct competition with the railways. An era of unbridled competition between these two forms of transport followed. In fact the transport history of Great Britain since the last war is a review of the efforts made by the State and the railways to evolve a co-ordinated scheme of passenger and freight transportation for the country.

In India road-rail competition has grown on somewhat similar lines, although, on the whole, it is much less acute. One important factor, that has tended to restrict the field of operation of the road haulier in India, has been the paucity of good roads until recently and the great distances between the various centres. The first of these is fast disappearing with the rapid improvement in road building, and ambitious programmes, which have been executed since the utilisation of the Road Fund out of the Petrol Tax, have become an established policy of Government. The phenomenal development in the design of the internal combustion engine has considerably strengthened the position of the road haulier to hold his own even over long hauls, which were formerly regarded as the especial domain of the railways. One thing, however, that has favoured the railways is the lack of organisation on the part of the road hauliers, but even this is quickly being made good, and much lost ground has been made up. Government control of transport undertakings, petrol, tyre, etc., rationing and the commandeering of motor vehicles may mitigate the severity of competition, but will be only a temporary spasm of relief. To be forearmed with schemes for the co-ordination of transport services against the arrival of an era of post-war peace and prosperity is an elementary precaution.

Attempts at the co-ordination of transport fall under two groups, *viz.*, measures adopted by the State through legislation calculated to control and restrict wasteful competition, and schemes promoted by the transport interests themselves by agreements, etc. It is clear that every country has to develop its own methods of co-ordination best suited to its individual requirements, and no panacea capable of universal application has yet been devised.

Before considering the methods adopted

for co-ordination it is just as well that we had an idea of the criteria upon which the efficiency of a transport service is judged from the consumer's point of view. The prospective passenger at the very outset demands easy accessibility to stations, information, tickets, etc. In this matter many places in India suffer as the result of lack of foresight on the part of the pioneers of railway transport in India. Adequacy of accommodation, punctuality, cleanliness, the guaranteeing of services and the ready availability of the amenities of travel loom large in the passenger's choice of the mode of transport. The trader desires prompt delivery of goods, freedom from damage or loss. Apart from these the management has its own standard for measuring domestic efficiency. Contented staff, minimisation of waste, and the incidence of accidents and the provision of safe and speedy transport at the lowest cost are the declared aims of all administrations. To the student of transport economics it is of immense interest to study and find out how far these ideals of service are capable of achievement by a co-ordination of the means of inland transport.

It is well known that for certain types of traffics the one or the other method of transport will be the better suited one. For instance, in the case of highly rated traffic moving rapidly in small lots over short distances, road transport easily scores over rail, and perhaps the day is not far distant when the aeroplane may replace the motor lorry. On the contrary, when, say, a huge transformer weighing a hundred tons or a gigantic modern naval gun has to be transported from one end of the country to the other, there is nothing that can touch the railway in the accomplishment of such a feat.

In this connection it is of considerable interest to investigate what weighs with a prospective customer of transport in the choice of the method. Only after understanding why one form of transport is preferred under given circumstances, will it be possible to devise a scheme whereby the different forms of transport can be so co-ordinated as to give the best and cheapest service, by doing away with the shortcomings of the type of transport not preferred, if that is the cheaper to produce. Recently in the United States a questionnaire asking under various heads why road transport was preferred to rail haulage was circulated nation-wide through the medium of the press. The replies make very interesting reading. The reasons determining the choice of the particular method of transport may be divided under service, cost and personal inclination or interest. The road haulier affords cheaper service by reducing packing requirements, lower rates, simpler accountancy and less incidence of damage and faster transport by later acceptance of goods and more flexible services. The same questionnaire also revealed that many did not prefer road transport to rail on account of lack of responsibility or failure to maintain proper services and the non-uniformity of rates or excessive loss or damage. It is of great importance that railways should study by similarly eliciting public opinion on the facilities they provide while shaping their commercial policy.

Before any method of co-ordination of transport becomes successful it is essential to have a clear idea of what types of traffic are best suited for one or the other method of transport. Another important point to be borne in mind is that road transport has come to stay, and all measures adopted by

the state or the railways should be directed towards the organisation of the two as complementary services, neither seeking to divert all the traffic to itself, and thereby occasioning wasteful competition, inconvenience and vain effort. At this stage it will be useful to note, in passing, what handicaps the railways suffer from, which have made road-rail competition such an unequal one. The railways in most countries of the world were partly, if not entirely, financed by the state. This has made the state reserve to itself certain rights, which have militated against railways being run entirely on a commercial basis. The first and perhaps the most important one is the limits imposed by the state within which the railways must quote rates, unless specifically permitted by the government to do otherwise. The railways cannot therefore reduce rates below a certain level to attract a special flow of traffic in competition with a road haulier, or put up its rates, should this be necessitated by commercial expediency. Then there is the "Undue Preference Clause" which prohibits any special treatment to any particular trader as against another. The road haulier is not similarly bound by restrictive regulations. The railways which have invested vast capital on track, rolling stock and other equipment find that in order to earn the standard revenue laid down by the government they must lay down a certain level of charges, having due regard to risks of conveyance, the capacity of the traffic to bear the rate, the type of stock to be provided, the capitalisation of the section of line, weights in relation to the bulk of the commodity and the loading qualities of the traffic. Railway rates are therefore higher than road rates, as road hauliers have an elementary method of rate-fixing, not being obliged to take into consideration the above factors, while building up their rates. Again the railways have scrupulously to observe every labour convention and see that their staff are not incurring too much "long hours of duty" and pay for overtime. In the case of the road haulage industry, for the most part, the small units are owner-operated, and the question of labour legislation observance does not come in at all. Also the commercial railway lines have to make good at least, in part, the loss in the working of the strategic lines. The plea for a "Square Deal" for the railways is therefore a very well-founded one.

In the matter of the co-ordination of their transport services different countries have adopted different methods. State control, by compulsorily nationalising their transport industry, and the enforcement by legislation that a particular method of transport should confine itself to the carriage of certain types of traffics under specified conditions are an ideal which is hard to achieve, except under totalitarian auspices. In India and Great Britain competition, within limits, in the field of transport has been regarded as essential to prevent monopolistic exploitation. In these countries neither road nor railway transport is entirely under government control. The same is true in America. The state being the supreme law giver can, by regulating legislation, and by a judicious road policy, so shape its transport system that the two methods of transport work as complementary units, performing the work best suited to itself and rendering the community the best service. The recent enactment by the Government of India of the Motor Vehicles Act has, by a system of licensing

lorries, done much to control uneconomic competition. Sometime ago the Sind Government undertook not to build a certain road, which would run parallel to the railway, and for which there was little traffic justification. Such action by the State has tended to keep the road operator to his field. A line of enquiry, which suggests itself at this stage, is the possibilities of the co-ordination of suburban passenger transport. In the larger cities of India like Bombay, Calcutta and Madras there is an enormous amount of passenger traffic carried by the suburban lines of the railways, the buses and trams. It is needless to say that there is some degree of competition between these, and the service rendered at present, though good, is capable of further improvement, if they are brought under a unified control, or if some method of the pooling of receipts and services is evolved. The value of such a system of control gains added emphasis in times of emergency. Besides the recent forecast by the Communications Member, that an enhancement in the near future of the suburban season ticket fares is not to be ruled out, might have the effect of diverting a considerable volume of passenger traffic to road (thereby adding to the congestion of city roads), should the forecast come true, unless there is also a corresponding increase of bus and tram fares. The latter can be assured most easily, if all the suburban services are operated by a single authority. One of the most succeseful experiments in this direction is the setting up of the London Passenger Transport Board in 1933, whereby the whole of the road and rail passenger services in the London suburban area was brought under a single authority, and the suburban passenger traffic receipts of the main line railways were pooled with those of the L.P.T.B., and each of the five parties received a fixed proportion from the pool, depending upon the extent of the suburban passenger services operated by each. The same type of co-ordination of passenger transport has been adopted in the city of New York.

Among the numerous methods adopted by the railways to avoid wasteful competition between them and the road transport undertakings may be mentioned their agreements with the road haulage industry. These agreements have sometimes taken the form of financial interests being acquired by railways, or buying up the business of road hauliers. In certain cases the railways have agreed with the road hauliers to provide services to fill in the gaps in railway services or to supplement them in outlying districts, or to act as feeders to a railhead. These agreements have proved very fruitful. In India the Nizam's State Railway has acquired a monopoly for road haulage as well in the State and has been able to produce a remarkable system of integrated services. The East Indian and S.I. Railways have been running long distance road services, and thereby affording a service, which has all the advantages claimed for road transport. This cannot however be called co-ordination, but is a case of successfully competing with the road haulier on equal terms. The North Western Railway has set up in conjunction with a local firm of road hauliers a joint stock company with the Chief Commercial Manager of the Railway as the Chairman of the Board of Directors, and the road services have been arranged so as to provide services at times when the railway itself cannot easily provide them, so that there is no break in the schedule in the twenty-four hours. This joint enterprise is working very

well. The introduction of "Agreed Charges" whereby traffic is held to rail for a period by the railway offering a flat rate for all the traffic based on a fixed charge per ton, irrespective of the distance of haulage, has produced very good results on the B.B. & C.I. Railway which was faced with the problem of combating coastwise country craft competition, which could afford to carry for next to nothing during the off fishing season. Development of air conditioning in railway travel has stimulated passenger traffic, but in a country like India, where the majority of people travel in the lower classes, other improvement in the travelling facilities to lower class passengers, will have a beneficial effect. The same can be said of the development of insulated, refrigerated or registered express and container transport for goods. Most of these innovations have been introduced by Indian railways in different parts of the country. It is however necessary that by undertaking a more elaborate publicity campaign they should be brought before the commercial community, and thus enable their benefits to be more widely appreciated.

Some of the measures, the railways might usefully consider to promote contact with the road undertakings for their mutual benefit, are to encourage, where possible, the bus services to use railway stations as their termini. This will easily enhance the goodwill between the railways and the omnibus people, and act as a good advertisement for the railways. Introducing a system of interavailability of omnibus and railways tickets, besides being advantageous to the public, is also beneficial to the railways, where traffic is sparse and is mainly on the road and takes away the edge from road-rail competition. Adjusting rail and omnibus timings so as to improve connectional services and the provision of special road and rail combined facilities may be put into practice with advantage. 'Publicising' omnibus timings in railway time tables, and the road industry reciprocating the courtesy, the erection of "bus stop" signs on railways premises and the displaying of selected road information at stations contribute largely in the promotion of harmonious working. A system of establishing road and rail charges for the same journey giving such a margin of difference that will neutralise the disability of the railway, where they suffer in the matter of accessibility of stations, or frequency of service, may produce encouraging results. Unremunerative branch lines may be closed and the transport needs of the locality met by agreement with the omnibus undertakings. The possibility of free conveyance of passengers by agreement with omnibus owners to railway termini where these are away from the towns' centres may be explored.

The lines on which future policy in regard to the co-ordination of transport may be based are firstly for the State to insist that the road haulage industry is organised on the lines of the railways, so that the two modes of transport can negotiate on an equal footing, and share alike the benefits of any co-ordination schemes. Road rates are as unstabilised in application as they are simple in structure. Legislation calculated to bring them more into line with railway rates, without introducing undue complications, is essential. The hours of work, wages, regulations, etc., must be made to apply in equal measure to both forms of haulage. The "Undue Preference" and "Common Carrier" clauses which are intended to safeguard the

public must also be made to apply to road rates. The publication of road operation statistics on the same lines as railway statistics are issued is very necessary to enable the public to know what is happening inside the industry, and any big profits accruing to the industry must be passed on to the users in the form of rate relief, etc. The setting up of the Transport Advisory Council and the Standing Committee for Roads is a step in the right direction.

The setting up of an organisation under the joint auspices of the road and railway undertakings entrusted with the task of collecting, analysing and collating all relevant information in regard to problems of common interest to the two industries is certainly worth serious consideration. This organisation can also serve as a clearing house for any outstanding problems at issue between them and advise when consulted in the matter of individual schemes of co-ordination. Problems for investigation may be also referred to this body.

The progress made in the co-ordination of road-rail transport has been considerable and has yielded very satisfactory results. Much ground still remains to be covered. If, however, the vigour, with which the problem is being tackled, should continue unabated, the day is not far off when a completely co-ordinated scheme of transport services will have been evolved.

C. N. R. RAU.

THE DECCAN TRAP

For half-three hundred years million, bowed down with monstrous weight
Of megalosaurs and dinosaurs and saurs of mountain height—
Our earth did groan in severe strain and cracked the Gondwan land,
When the bridge, which spanned the Vindhyan land and the Afric's southern rand,
Submerged—sundered in shattered blocks—beneath the Arab main
And sought the sheltered abyssal depths of Neptune's dark domain.
The Vindhyan land then belched, in gasps, a lurid lava-melt
Through ripped out clefts and rifts afar, in its pent-up strain-filled belt.
The fiery flows from Vulcan's bowl did blaze a burning red
And with gory glow, from down below, they stained the starry bed.
Those bursts of flows—like geysers' surge—had quiescent intervals,
When algal plants and water ferns found tombs with Physa shells.
These Vulcan's pastes did scald the land for miles half million square
And, laid—in steps—to lofty heights, they built a rocky stair.
Their congealed crust, like lakes of jet, did fill the Vindhyan's lap
And cleft and carved by Time's deft hands, it hails now "Deccan Trap".
Its winding glens, at Konkan's edge—with verdant forests fine—
Do run along for miles on miles, like a mazy Maginot line.
Welled these Traps from Vulcan's pools on the wane of Chalk-age day
Or at dawning stage of Tertiary age, as some maintain to-day,
Is a wordy war which rages now with Earth-Science men of Ind,
Who group themselves in fighting ranks to hurl their fossil find.
Sahni's ferns and Hora's fish and Raos's algal cells,
Are thrust to fore to oust the force of Oldham's mollusc shells.
These fossil folk do fight their feuds with Parker pocket pens
And shed their blood—in Quink liquid—in tome-filled dusty dens.
The world moves on unnerved by this,—the fate of Trap-age fight,
To delve Earth's past and date her deeds are not for vulgar wight;
The Earth revolves unchained by this—the Trap-age tangled knot,
She smiles aloof and shouts aloud, "To me it matters not;
The dawn which spanned the Chalk-age night and the morn of Tertiary days,
A tick it counts in endless time: an inch, in boundless space."

R. R. B.

THE ELECTROSTATIC GENERATOR FOR NUCLEAR DISINTEGRATION

BY

C. K. SUNDARACHAR* (*University of Mysore, Bangalore*),
J. F. STREIB (*Calif. Inst. of Technology, Pasadena*) AND
B. V. RAGHAVENDRA RAO (*University of Mysore, Bangalore*)

THE electrostatic generator of the moving belt type first developed by Van de Graaff[1] as a high voltage source and later successfully adapted for use with an accelerating tube by Tuve[2] at Washington and Herb[3] at Wisconsin has proved to be a relatively inexpensive and compact apparatus for the production of high velocity protons or deuterons of 0·5 to 3 M.e.V. energy for nuclear disintegration experiments. The homogeneity in energy of the ions which it can yield to the extent of the fraction of a percent and the accurate control of voltage which it affords have made it particularly valuable in the study of proton-proton scattering[4] which is of considerable theoretical interest and the study of resonance effects at energies corresponding to stationary states of the nuclear system. It is also well suited for the accurate measurement of the thresholds of nuclei for emission of neutrons under proton bombardment as well as of the angular distribution of disintegration products in regard to which the experimental data are meagre and the close study of which will reveal the nature of the interaction of angular momenta of the incident and bombarded particles.

The cyclotron extensively developed,[5] at the University of California and of which there are nearly a dozen operating in different parts of the world at the present time can yield several hundred micro-amperes of positive ions of energies 5 to 15 M.e.V. While this feature makes the cyclotron especially suitable for breaking up heavy nuclei and for producing large quantities of radioactive isotopes of possible therapeutic value, the considerable expense involved in its construction and the variation in ion energy by as much as 10 per cent. offset these advantages. Condenser-rectifier voltage multiplying sets of the type[6] developed by Cockcroft and Walton are used in some laboratories and give a good yield of positive ions at steady voltages. Commercial installations of this type of high voltage source yielding more than 1 M.V. are, however, very expensive. The cascade transformer which has been used effectively at the high voltage laboratory at Pasadena[7] and at Ann Arbor, Michigan[8] has proved useful for large neutron yields and in the study of gamma ray spectra where high intensities are necessary. It suffers from the main disadvantage of inhomogeneity of the ion beam. The steadiness of voltage and relative inexpensiveness combined with the fact that the parts can be easily built and assembled make the electrostatic generator with the accelerating tube unit ideally suited for physical laboratories with limited financial resources. The main features and the recent developments in its technique are set down in this article.

Essentially, the electrostatic generator consists of a spherical or cylindrical metal dome, one to two metres in diameter, supported on a textolite or flanged porcelain insulating support about 10 feet high and raised to a high positive potential by a rapidly moving belt, on which is sprayed electric charge by means of a comb system connected to a 10–20 K.V. transformer-rectifier set. The multiple section ion accelerating tube inside which the vacuum is maintained to less than 10^{-4} mm. of Hg by a set of big size oil diffusion pumps, is supported along the axis of the insulating tower. The hydrogen or deuterium discharge tube used as the source of ions, the gas holder, the generator and transformer-rectifier units for the supply of filament current, anode and probe voltages are all housed inside the dome. The gas flow and potentials are adjusted by conveniently arranged strings operating the controls.

Assuming a breakdown potential for air at ordinary pressure equal to 30,000 volts/cm., the maximum current conveyed by an 18-inch wide belt running at 3,600

* Visiting Professor at the California Institute of Technology, Pasadena, U.S.A., 1939–40.

ft./minute and arranged to carry both kinds of charge works out to be 450 micro-amperes. It is found, experimentally, that 75 per cent. of the theoretical current is delivered to the high potential electrode. The voltage is adjusted by the control of the spray voltage or by the use of a moveable "poker" consisting of a set of points placed close to the dome. If the belt system is enclosed in a steel tank filled with compressed air at about 100 lb. wt./sq. in., the available voltage is increased[9] by a factor of 2 to 3. Fig. 1† gives a sketch of the

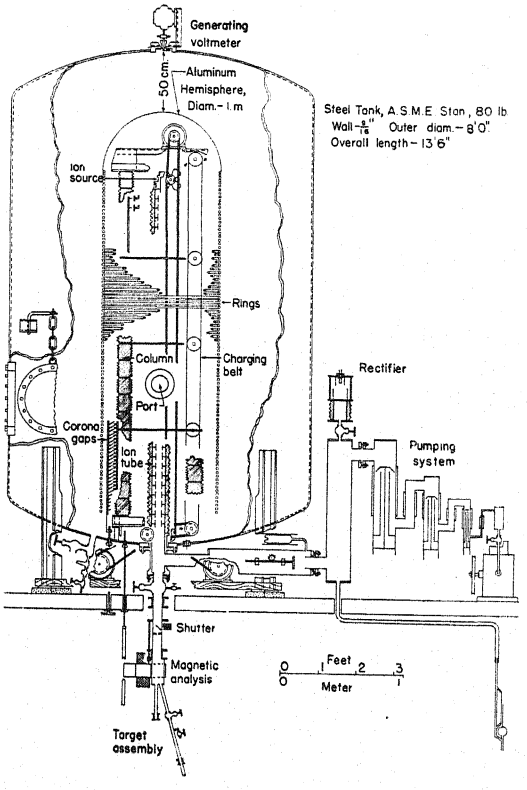


FIG. 1

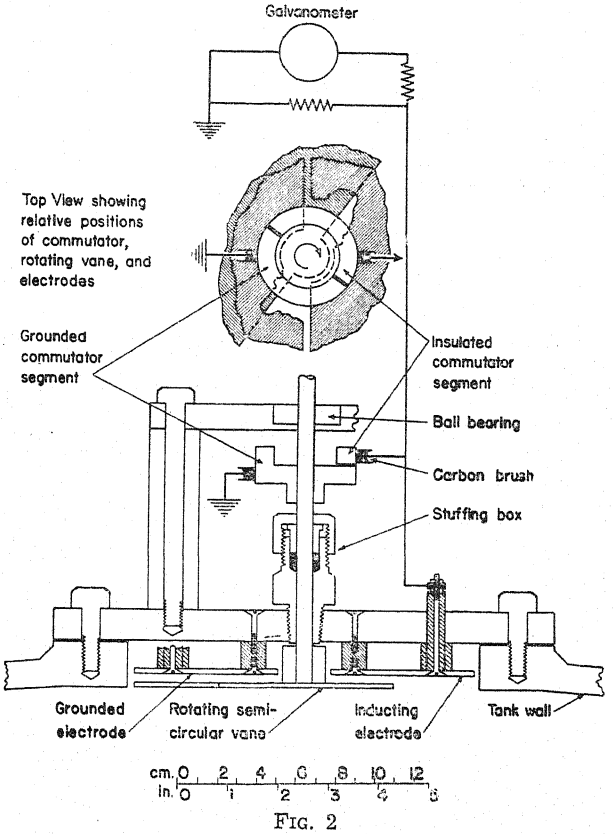


FIG. 2

surfaces inside it and a set of adjustable negative point to plane gaps between adjacent rings produce corona current down the ring system and helps to regulate the voltage on the ion tube as well as the different electrodes (20 to 50 in number) constituting the electron lens system of the accelerating tube. Ample room is available inside the ring system for the insulating supports, belts and accelerating tube. Adverse stray currents arising from insulator leakage, corona from rough spots and discharges in the tube make it necessary to

pressure electrostatic generator (1–2 M.V.) built at the Kellogg laboratory of the California Institute of Technology, Pasadena and which has been extensively used for the study of fluorine-proton nuclear reactions. A series of metal rings surrounding the tower serve to define equipotential

† We are indebted to Professors Lauritsen and Fowler of the California Institute of Technology for permission to reproduce Figs. 1 and 2.

have an adjustable corona current across the ring system. It is found[10] that the maximum current which can be drawn from a point to plane corona before breakdown occurs is about 200 micro-amperes. The focussing of the ion beam is controlled chiefly by the potential adjustment of the first few electrodes of the electrostatic lens system. The theory of focussing has been worked out in considerable detail.[11] A focal spot of 3 to 4 mm. diameter with an ion

current of 10 micro-amperes can be obtained with a well-designed ion source, which may be of the hot filament, low voltage or the capillary arc type. The ion beam is separated into its mass spectrum by an electromagnet.

Since concentric electrodes surrounding the charged dome give rise to a more uniform gradient and since high pressure air withstands higher gradients in shorter gaps the use of concentric electrodes increases the spark-over voltage. The available voltage in the latest type of pressure generator housed in a tank (20 ft. × 5½ ft.) at Wisconsin[12] is found to increase from 2·6 to 3·5 M.V., using an arrangement of concentric electrodes.

The voltage is generally measured by means of a generating voltmeter.[13] In one type, the alternating current generated by a spinning disc is measured by a sensitive galvanometer after rectification by a commutator. Fig. 2 gives a sketch of the arrangement used with the generator at Pasadena. Calibration is usually performed using the 440 K.V. peak of gamma ray resonance of the lithium-proton reaction. The sharpness of the proton induced neutron emission reactions indicates that they also may be useful for calibration in high voltage work.[14]

[1] Van de Graaff, *Phys. Rev.*, 1931, **38,** 1919.

[2] Tuve, Hafstad and Dahl, *Phys. Rev.*, 1935, **48,** 315.

[3] Herb, Parkinson and Kerst, *Phys. Rev.*, 1937, **51,** 75.

[4] Heydenburg, Hafstad and Tuve, *Phys. Rev.*, 1939, **56,** 1078.

[5] Kurie, *Journ. App. Phys.*, 1938, **9,** 691.

[6] Cockcroft and Walton, *Proc. Roy. Soc.* (A), 1932, 136, 619.

[7] Stephens and Lauritsen, *Rev. Sci. Inst.*, 1938, **9,** 51.

[8] Crane, *Phys. Rev.*, 1937, **52,** 12.

[9] Parkinson, Herb Bennet and McKibben, *Phys. Rev.*, 1938, **53,** 642.

[10] T. Lauritsen, Ph.D. Thesis, C.I.T., 1939.

[11] Kirkpatrik and Beckerley, *Rev. Sci. Inst.*, 1936, **7,** 24; Klemperer and Wright, *Phys. Soc. Proc.*, 1939, **51,** 296.

[12] Herb, *et al.*, *Phys. Rev.*, 1940, **58,** 579.

[13] Harnwell and Van Voorhis, *Rev. Sci. Inst.*, 1933, **4,** 540.

[14] Haxby, Shoupp, Stephens and Wells, *Phys. Rev.*, 1940, **58,** 1035.

MANUFACTURE OF DRUGS FROM INDIGENOUS RESOURCES

"BORIC acid for the Medical Stores Department, hitherto obtained from England, may shortly be manufactured in India. It is proposed to purchase crude borax, imported from Tibet, and arrange for the manufacture of the boric acid. Another imported article, tablets Magnesii Sulphas 40 grains, is being manufactured by one of the Medical Stores Depots.

"Peptone powder, used as a culture medium, has hitherto been obtained from England. It is now manufactured in India. A sample has been tested by the Military Laboratories and found to be a suitable substitute for the imported article. Accordingly the article has been transferred to the list of indigenous articles." It may be added that Mr. B. N. Sastry and his colleagues, working at the Indian Institute of Science, have perfected a process for the manufacture of peptone from fibrin by subjecting the material to the action of integrally pure papain.

SIR SHANTI SWARUP BHATNAGAR, Kt., O.B.E., D.Sc., F.Inst.P., F.I.C.

WE have pleasure in offering SIR SHANTI SWARUP BHATNAGAR, our heartiest felicitations on the Knighthood recently conferred on him. He is one of the most distinguished scientists in the country, who assumed the appointment of Director of Scientific and Industrial Research last year.

Professor Bhatnagar is well known for his researches on surface tension, emulsions and other branches of colloidal chemistry. Besides these he has worked in almost every branch of physical chemistry, but his most important work relates to magneto-chemistry, a subject which has come into prominence in recent years. Professor Bhatnagar and his pupils have contributed a very large number of important papers on the subject. His work has found reference in all the important books on the subject and constitutes the major bulk of two monographs on the subject of Emulsions and Emulsifications by Dr. Clayton of the British Association Committee for Colloidal Research. The Bhatnagar-Mathur Interference Balance devised by Professor Bhatnagar is a very sensitive instrument for measuring the magnetic susceptibility of substances, and its manufacture has been taken up by the famous London firm of Messrs. Adam Hilger, Ltd.

Professor Bhatnagar's brilliant work in the domain of colloids was mainly responsible for his association with the Oil Industry in the Punjab. The Attock Oil Co., Ltd., were finding difficulties in the drilling of their wells. Due to the close proximity of the drilling range they were finding that the mud used in drilling was coagulated and refused to flow. The foreign experts had not met with this difficulty anywhere before and though the problem was referred to several experts in Europe and America, no satisfactory solution was forthcoming. They then approached Dr. Bhatnagar for his help. Within six months his experiments were completed and the measures suggested by him were found to be very useful by the Company's experts.

Messrs. Steel Brothers and Co., Ltd., were quick to realise the important advantages that they stood to gain by association with research. Several personal offers were made to Professor Bhatnagar, but he turned all these down and insisted on everything being done under the auspices of the Punjab University. The result was the inauguration in 1934 of the scheme of Petroleum Technology Research sponsored by Messrs. Steel Bros. & Co., at a cost of Rs. 1¼ lakhs to be spent in 5 years in the first instance. The scheme has since been extended to 10 years at a total cost of Rs. 4 lakhs.

Within the short period that has elapsed since the inauguration of the scheme Prof. Bhatnagar has completed several important investigations as a result of which Messrs. Steel Brothers have taken out several patents. Perhaps the most important of these is the one relating to the increase in the luminosity of kerosine oil. As a result of the process worked out by Prof. Bhatnagar it has been possible to increase the height to which the kerosine flame can be raised without giving out smoke to nearly three times the usual height at a cost of a fraction of an anna per gallon.

The other important process relates to the treatment to be given to paraffin wax and

vegetable oils to prevent the development of rancidity. The importance of this process to India will be realized when it is mentioned that 90 per cent. of the world's supply of paraffin wax comes from India and Burma. The process will be of great benefit to all the industries which utilize these articles especially those where the products are required for human consumption or cosmetic purposes. Messrs. The Tata Oil Mills Co., Ltd., have acquired the rights of utilizing this discovery so far as it relates to vegetable oils from Messrs. Steel Brothers.

These and other important researches of Dr. Bhatnagar have made the Indian industrialists realize the importance of research to industry and while at Lahore Professor Bhatnagar had in his hands a number of problems from Indian industrialists like Lala Shri Ram of the Delhi Cloth Mills, for whom Dr. Bhatnagar has already patented a process for producing a soft and lustrous cloth from material hitherto regarded waste; The Lahore Electric Supply Co., who are erecting a plant for the manufacture of white lead; The Tata Oil Mills Co., Ltd., and the famous Birla Brothers of Calcutta. The grants made by these industrialists were being spent in maintaining scholars and meeting the cost of their work.

In the exalted position which he now occupies, he enjoys the unstinted support of his scientific colleagues and the confidence of the Government of India. His opportunities for promoting and consolidating the industrial expansion and economic prosperity of this great country are almost unique, and judging by the manner in which he has been initiating measures for the advancement of both by organising scientific researches in all branches of applied knowledge, we believe that India is already treading the high road to industrial and economic greatness. How soon it will be reached must necessarily depend upon the policy of the Government of India.

SIR RAM NATH CHOPRA, Kt., C.I.E., M.A., Sc.D. (Cantab.), F.N.I., F.R.A.S.B., F.S.M.F., M.P.S. (Hon.) (Lond.), Brvt.-Col.*

THE distinction of Knighthood conferred on DR. RAM NATH CHOPRA has given great satisfaction to his friends, and to the numerous felicitations, which he has already received, we add our own, which though late, are most cordial. His name is held in great respect by the medical profession in India to whose prestige and reputation he has added the fresh lustre of an impressive record of scientific researches of far-reaching importance. Like Sir Shanti Swarup Bhatnagar, Sir Ram Nath Chopra comes from the Punjab.

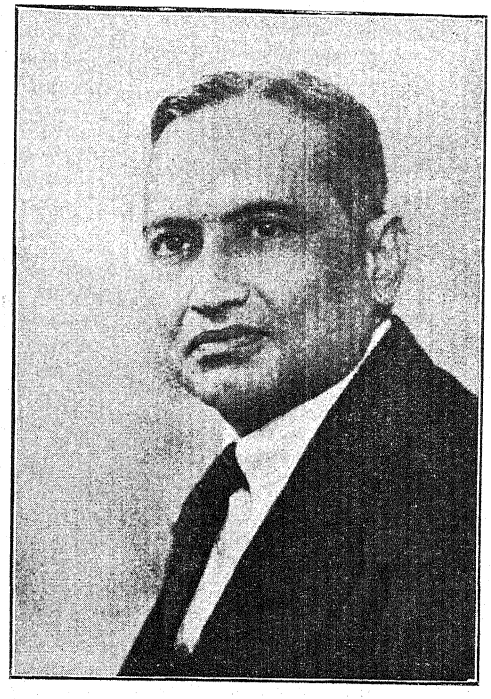
Even in his early days in the colleges, Sir Ram Nath showed a strong predisposition for conducting original investigations, and the subject in which he was most interested at the time, and whose whole complexion his later discoveries embellished, was pharmacology. While working in the laboratory of the late Professor W. E. Dixon, he produced a thesis on "The Action of Drugs on Ciliary Movement" on the merits of which the young Ram Nath Chopra received the Doctorate Degree in Medicine of the London University. When in 1921, he joined the School of Tropical Medicine as Professor of Pharmacology and Physician to the Carmichael Hospital for Tropical Diseases, Dr. Chopra had served in East Africa and later worked with the British expeditionary force in Afghanistan. Dr. Chopra's work soon laid the foundation of a brilliant school of research in Indian pharmacology, and the contributions from him and his colleagues form a glittering memorial to the institution and constitute an inspiring chapter in the evolutionary history of the Western medical science in India.

With the able collaboration of Prof. Sudhamoy Ghosh and his assistants, a large amount of work on the botanical, pharmacological and therapeutic aspects of Indian varieties of known plants in pharmacopœia has been carried out. This has given us a very valuable knowledge regarding the possibilities of cultivation and economic exploitation of such plants as Ephedra, Belladonna, Aconitum, Artemesia, etc.

The research work on the action of the

* This note is based on a brilliant article written by Rao Bahadur Dr. T. S. Tirumurthi on the occasion of the honour of Knighthood conferred on Sir Ram Nath Chopra.

indigenous drugs of India is one of far-reaching importance. Though no epoch-making discoveries have been made, this inquiry has shown that only a limited number of the remedies deserve the reputation they have earned as cures. The field of research in this domain is a vast one and much is yet to be done, as Col. Chopra himself has said so often. A herbarium representing two-thirds of the total species of known medicinal and poisonous plants occurring in India has been established in Calcutta, and a monograph on 'Poisonous plants of India' is now ready for publication.



Perhaps the most valuable and well-known of Chopra's work was his report as the Chairman of the Drugs Enquiry Committee (1930–31). This report will remain as the best and most authoritative and outstanding publication on the subject of the "Control and standardisation of drugs in the Indian market". The report of the Committee drew attention to the complete lack of control over the trade in drugs and chemicals in this country, and suggested legislation for this purpose. The Drugs Act (1940) was the result of this work and the consistent agitation carried on since then. Even before the Government decided to impose standards for drugs, Chopra was primarily instrumental in establishing the Biochemical Standardisation Laboratory in the All-India Institute of Hygiene.

Col. Chopra was elected a Fellow of practically all the scientific bodies and educational organisations in India including the Royal Asiatic Society of Bengal, the University of Calcutta, the State Medical Faculty of Bengal, the National Institute of Sciences of India, and the National Academy of Sciences. In 1925 he was elected President of the Medical and Veterinary Research Section of the Indian Science Congress, and again in 1938 the President of the Physiology Section during its Jubilee Session. In recognition of his services, he was conferred the honour of C.I.E. in 1933. He was appointed Honorary Physician to His Majesty the King in 1935, and was promoted to the rank of a Brevet-Colonel. International recognition of his work has not also been slow to come. In 1937, the Cambridge University admitted him to the Degree of Doctor of Science, a very high distinction, and the Barclay Memorial Medal of the Royal Asiatic Society was awarded to him in 1938. The same year he was elected a Fellow of the Royal College of Physicians of London and also an Honorary Fellow of the American Society for Pharmacology and experimental Therapeutics. The latter recognition is a very coveted one, in view of the fact that there are only three other Honorary Fellows of this Society—Prof. Hans Meyor of Vienna, Prof. Straub of Munich, and Sir Henry Dale of London,—all three internationally-known pharmacologists. In 1939, he was made a Fellow of the Belgian Society for Tropical Medicine, and he received a congratulatory message from the President of the German Pharmacological Society.

Though officially superannuated Sir Ram Nath Chopra is practically as alert and active as he was when he entered service and we wish him many happy years of notable research in the special field of medicine, which he has adorned by unremitting labours and by penetrating insight.

SIR C. V. RAMAN, F.R.S., N.L.

AT a recent meeting of the Board of Managers of the Franklin Institute of the State of Pennsylvania, it was voted unanimously to award the **Franklin Medal** to SIR CHANDRASEKHARA VENKATARAMAN, *"in recognition of his many brilliant contributions to physical science and of his leadership in the renaissance of scientific work and scientific education that has occurred in India during the last thirty years"*.

The Franklin Medal is the highest award in the power of the Institute to bestow. It was established by Samuell Insull in 1915, and has been awarded for signal and eminent service in science. Arrhenius, Bragg, Dewar, Edison, Einstein, Lorentz, Marconi, Michelson, Planck, Richards, Rutherford, Thomson, Weston, Whitman, Wright and Zeeman are among the distinguished recipients.

Well over a hundred young men—mathematicians, physicists, chemists, and geologists—have had their training in research under Raman. The publications issued from Raman's Laboratory both at Calcutta and at Bangalore cover a dozen branches of physics, and include well over six hundred titles of papers. A bibliography of these publications would not however convey a sufficient idea of the influence—direct and indirect—which Raman has exercised on the promotion of science in India. Many of his past pupils occupy important positions all over the country as Professors, Readers or Lecturers in the Universities, or as members of the Government scientific services. His personality has exerted a profound influence on the growth of an active scientific atmosphere in India during the last thirty years.

We beg to offer to Sir C. V. Raman, our congratulations on this great distinction.

MANUFACTURE OF SCIENTIFIC STORES

THE Principal Information Officer, Government of India has announced that the Supply Department is examining a list of scientific stores to determine which of the items therein could be manufactured in this country. This commendable step will be welcomed by every one interested in the manufacture of scientific instruments and industrial equipment in this country. We have, no doubt, that there are a number of firms who are interested in the manufacture of a few of these and other allied items, but there is a vast number of instruments for which the country is still dependent upon foreign import. It is hoped that the Government of India will give the necessary protection to the scientific instruments industry in the country, so that the manufacturers who may take up this industry under the stress of war may be enabled to establish this key industry on a sound and profitable basis, even after the return of peace.

DR. HOMI J. BHABHA, F.R.S.

INDIAN Scientists, and Physicists in particular, will learn with great joy that DR. HOMI J. BHABHA has been honoured by a Fellowship of the Royal Society of London. That this should have come at such an early age and on the first nomination is a fitting recognition of his brilliant researches. The conferment of this distinction on two Indian Physicists during the year is a clear indication of the momentum that the study of pure science for its own sake has acquired in this country and the international recognition it has earned for itself.

Born in the year 1909 Dr. Bhabha took his early University education at the Royal Institute of Science, Bombay, and at 17 he joined Gonville and Caius College, Cambridge. After taking the Mathematical Tripos Part I, he changed over to engineering and took the Mechanical Sciences Tripos in 1930. But the engineer soon turned Physicist, and like Prof. Dirac he took to mathematical physics. He got his early training under Profs. Dirac and N. F. Mott at Cambridge and later under Prof. W. Pauli at Zurich. He made useful contacts with great scientists on the Continent by working in turn with Prof. Fermi at Rome, Prof. Krammers at Utrecht and Prof. Niels Bhor at Copenhagen.

From 1935 onwards Dr. Bhabha lectured at the University of Cambridge till the outbreak of War cut short his career there. Since his return to India he has spent most of his time at Bangalore, where he has continued his researches at the Indian Institute of Science and given lectures on theoretical physics.

His presence in India is largely responsible for the great rise in interest in the study of cosmic radiation in which he is an authority.

His later years at Cambridge were very fruitful to Dr. Bhabha from the view-point of scientific research. His first important work was a paper with Heitler on the cascade theory of cosmic ray showers which appeared in the *Proceedings of the Royal Society* in 1937. In the following year he published two other important papers. The first showed the existence of a new fundamental particle in the penetrating component of cosmic radiation and the second gave the quantum theory of this particle, which has now been called the meson. The first paper also explained the production of showers by the penetrating component through the agency of collision electrons, by a process which is now called after Bhabha. There were nevertheless serious difficulties in the quantum theory of mesons and during the last two years Dr. Bhabha has given solutions of these difficulties in three papers. Two of the difficulties were connected with the scattering of mesons, which as predicted by the old theory was in disagreement with observations. Dr. Bhabha's solution of this difficulty predicts two new fundamental particles, and points the way to future experiments.

Dr. Bhabha's most serious hobby when he is away from physics is painting, and apart from his pictures, he has designed and painted the Stage Decor of several Operas and plays which were produced at Cambridge. Such a rare combination of artistic and scientific talent is certainly very refreshing to any one who comes in contact with him. It is with sure confidence that we can expect greater successes from this scientist.

VIKRAM SARABHAI.

THE SEVERE MAGNETIC STORM OF MARCH 1, 1941

BY

M. R. RANGASWAMI

(Colaba Observatory, Bombay)

A SEVERE magnetic storm was recorded by the magnetographs at the Alibag magnetic observatory at $03^h\ 58^m$ GMT, on Saturday, the 1st March 1941, with a characteristic "sudden commencement" in all the three elements. H rose instantaneously by 42 gammas and westerly D by 1·4 minutes of arc. There was a simultaneous fall of 15 gammas in Z. When attention is confined to the H magnetogram it is seen that the force fluctuated with small-period oscillations till $05^h\ 08^m$ whereafter it rose rapidly by 132 gammas in thirty minutes reaching its maximum at $05^h\ 38^m$. Then a fall with oscillations followed till $07^h\ 06^m$ after which time once again a rapid rise of 91 gammas occurred in fifteen minutes. $07^h\ 21^m$ marked the beginning of a rapid fall which continued till $09^h\ 27^m$. The fall in H during this interval of a little over two hours amounts to 354 gammas. After this a gradual rise in H began with oscillations till $13^h\ 13^m$ when once again a fall and that, a very rapid one, commenced. In this case H decreased by 334 gammas in 46 minutes and was still falling, when unfortunately the light speck went off the scale at $13^h\ 59^m$, and the H record was lost for about 96 minutes. At $15^h\ 35^m$ the light speck was brought within the margin of the photographic paper by a controlling deflector magnet which was strong enough to shift the trace by 276 gammas. The

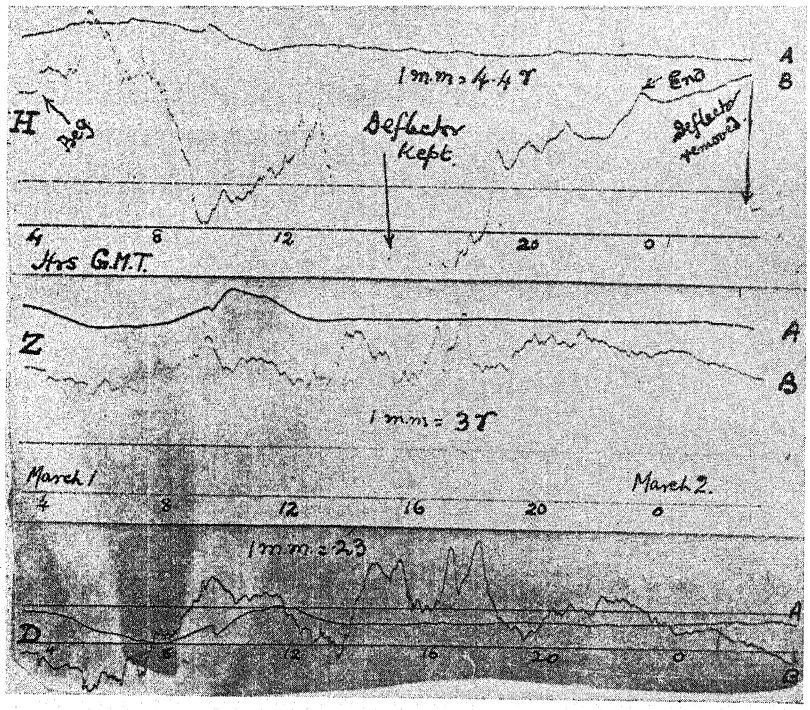


FIG. 1

H, *Z* and *D* magnetograms recorded at the Alibag Observatory
A—Records for the day previous to the storm
B—Records for the day of the storm (1st March 1941)

presence of the deflector, however, could not prevent the loss of record for any appreciable time. Hardly four minutes elapsed, and the speck was once again below the margin of the paper due to a further large decrease in the value of H. This loss of record could not be prevented as there was no provision to keep the deflector magnet at a much nearer distance. Arrangements are now being made to prevent such loss in the future. The speck reappeared on the photogram at $17^h\ 48^m$ whereafter the oscillations began to die gradually with the slow rise in the force. The storm practically ended by $23^h{\cdot}5$ on March 1, but the value of H was still about 265 gammas below its pre-storm value. From the nature of the trend of the trace at minimum time it appears that the H range during this storm has exceeded 785 gammas by a moderately large amount. The D and Z ranges during this storm were 16 minutes and 130 gammas respectively. The magnetograms of this storm together with those for the day previous to the storm have been reproduced in the figure for comparison.

PREVENTION OF GHEE ADULTERATION

AT an informal conference of ghee packers convened by the Agricultural Marketing Adviser to the Government of India and held in Delhi on February 19 under the presidentship of Mr. P. M. Kharegat, C.I.E., I.C.S., Vice-Chairman of the Imperial Council of Agricultural Research, the adulteration of ghee with *Vanaspathi* and the rapid rise in the price of ghee due to the abnormal demand for the military department, were discussed.

The following steps, among others, were recommended to check the adulteration of ghee:—

(i) Extension of the Food Adulteration Laws to the whole of a province or state instead of their scope being limited to certain municipal or town areas.

(ii) Delegation of power to Marketing Officers to carry out inspection under the Food Adulteration Acts.

(iii) Sale of *Vanaspathi* in sealed and labelled tins.

The conference also decided that the Federation of Agmark Ghee Packers might consider the desirability of approaching the Supply Department with the proposal that Agmark ghee might be purchased for future army requirements.

It was revealed at the conference that on account of high acidity in ghee during summer months, very large quantities of ghee cannot be marked with the Agmark label, particularly in the United Provinces and Bihar. It was, therefore, agreed that the maximum percentage of acidity of general grade be raised from 2·5 per cent. to 3 per cent. It was further agreed to have the same chemical standards for special and general grades except in regard to acidity.

On the question of sub-packing stations, there was general agreement that authorised packers might be allowed to have sub-packing stations provided satisfactory arrangements could be made for the testing of raw ghee at each of these sub-stations.

REVIEWS

An Introduction to the Kinetic Theory of Gases. By Sir James Jeans. (Cambridge University Press), 1940. Pp. 311. Price 15*sh.* net.

The credit of having presented in English for the first time the Kinetic Theory of Gases 'upon as exact a mathematical basis as possible' goes to Sir James Jeans. The first edition of his *The Dynamical Theory of Gases* appeared in 1904, and many students of Physics as also many mathematicians drew their sustenance from that book in spite of the stiff treatment of the subject. Other editions which appeared in 1916, 1921 and 1925 included more material such as the treatment of the Quantum theory. The present edition is less costly and is within the reach of the average serious student of the subject. This may perhaps be due to the size of the book being much smaller than before. It may look less imposing, but surely it is less forbidding, and is certainly more inviting to students of science. Evidently the appearance of many special treatises on the Quantum theory in recent times has induced Sir James Jeans to effect a thorough change in the scope of the present book, and there is hardly any reference to the Quantum theory. Even so, other subjects of interest such as Aerostatics are omitted.

To a very large extent the contents of the earlier editions are retained here often in the same words. New material has been included under the heads of the experimental tests of Maxwell's Law of Distribution of Velocities, and Perrin's work on the Brownian Movement. But it is surprising that Sir James Jeans has not touched on any of the more recent and the fascinating developments of the subject such as Low Pressure Phenomena, Fluctuations and the Electric and Magnetic properties of gases. There must have been very strong reasons for not including them, but we confess to a feeling of disappointment. His remarkable way of writing raises expectations in us; but he seems to have decided that they need not be gratified. The master mind which has given such an admirable treatment of the famous theorem of persistence of velocities could throw a flood of light on these newer phases of the subject much to the advantage of the student of physics and physical chemistry.

In this connection one recalls to mind the concluding sentences in the *Mathematical Theory of Electricity and Magnetism* by the same author. Referring to the newer concepts introduced by the Quantum theory he writes "..... the limiting case provides a bridge between the old mechanics and the new; on one side of the bridge the classical electrodynamics holds undisputed sway, but as we cross the bridge and advance into the territory on the other side, the additional restrictions imposed by the Quantum dynamics become ever more important, until finally they may be considered to govern the whole situation. The exploration of the territory on the far side of the bridge will provide work for a new generation of mathematical physicists; the present work attempts only to bring the reader as far as the bridge, and to make clear to him that if he crosses it he must expect to find different conditions prevailing on the other side". In the domain of Kinetic Theory of Gases we are now led by Sir James Jeans only as far as a similar bridge though his guiding hand in the new territory would have been invaluable and unique.

The Cambridge Press has as usual got up the publication quite nicely though it is hard to understand how some minor typographical errors have crept in, as for instance on page 160 duo/dx is printed instead of duo/dz, and this error occurs twice in rapid succession on the same page.

P. SRINIVASA ROW.

Mathematics of Statistics. By John F. Kenney. Part I. 1940. Pp. x + 248. Price 12*sh.* 6*d.*

Mathematics of Statistics. By John F. Kenney. Part II. (Chapman & Hall, Ltd., London), 1940. Pp. ix + 202. Price 11*sh.*

The author states that his object has been "to write an up-to-date text which will serve to prepare the student for the really mathematical part of the theory of statistics". He has succeeded in producing a useful compilation which will serve as a standard text-book for statistical teaching. Important aspects of the subject have been covered in an adequate manner on the whole;

and obscure and unfamiliar ideas have been clearly explained.

The book is divided into two parts. The first part deals with what may be called descriptive methods, and the second part with sampling theory. This relegation of the theory of distribution to the very end has resulted in some lack of definiteness both in notation and ideas in the earlier part. But this may be unavoidable in an elementary text-book; and the wise course may be to leave the beginner to get his ideas about statistical inference clear after he has become familiar with the more descriptive portions of the subject.

Part I starts with an introductory chapter in which the scope of the science of statistics is treated in a concise but lucid manner, with some interesting observations on the relation between mathematics and statistics. Chapter I deals with frequency distribution on familiar lines. The distinction between class limits and class boundaries is clearly explained, but the difficulty of boundary points is avoided by taking the class boundary to a higher place of decimal than that used in the primary material. The treatment of 'graphical representation' in the second chapter is rather meagre, and can be amplified with advantage.

Chapter III deals with averages of various kinds such as the arithmetic, geometric and harmonic means, modes, medians, etc., in the usual way on purely algebraic lines. In every case the results are given in the form of abstract theorems. This may be convenient for a purely formal development of the subject, but it is not clear how far this is either necessary or desirable for teaching purposes.

The fourth chapter on moments gives a useful summary of algebraic results including an elementary description of Sheppard's correction. Some reference might have been made at this stage to associated symmetric functions like semi-invariants and cumulants which are being increasingly used in theoretical investigations. It is worth noting that new symbols, namely, α_3, and α_4 for the Pearsonian $\sqrt{\beta_1}$ and β_2, are introduced presumably to avoid confusion with the so-called β-coefficients in correlational analysis which are extensively used in the United States. The β_1 and β_2 notation is, however, so deeply ingrained in Pearsonian literature that a change of notation is likely to be merely confusing. If the Pearsonian approach is to be given up, the simplest plan would be to adopt directly the cumulant and k and kappa notation of R. A. Fisher.

Chapter V gives a general description of measures of dispersion. Skewness and kurtosis are explained briefly in Chapter VI together with a fuller treatment of the normal curve and its important properties. The next Chapter VII deals with curve fitting in an elementary manner. Time series and exponential trends and ratio charts are also briefly discussed together with a useful description of the Gompertz curve in this chapter. The Pearson family of curves requires fuller treatment; and other well-known systems deserve mention. Perhaps the best plan would have been to discuss systems of curves in greater detail in Chapter VII, and devote a new chapter to the discussion of time series and other curves.

Chapter VIII is taken up with the elements of correlation theory and associated topics such as the coefficient of alienation. There is a general description of the normal bivariate frequency surface with an elementary treatment of non-linear regression and Pearsonian η^2, and a discussion of tests of linearity on older lines which is not adequate.

Part I is complete by itself. Special features are the large number of exercises at the end of each chapter, and the review questions and problems at the end of the book. There are two appendices giving the ordinates and areas of the normal curve to five places of decimal, and the common logarithms of numbers to five decimal places.

Part II deals with more recent analytic developments, and gives in a convenient form a useful summary of the essentials of the theory of sampling distributions. Chapter I starts with elementary topics of probability. No attempt is made to go into logical foundations. Thus the ratio of frequencies is accepted as the basis of the definition of probability, and the concept of the limit of the ratio is introduced without any discussion. This is followed by the usual theorems in permutations and combinations and a fairly full treatment of the binomial distribution. The approximation to the binomial with the normal curve is discussed in considerable detail. The simple sampling of attribute is then considered, and the probable error is introduced. The discussion of standard errors and correlation of errors in class frequencies is particularly

worth noting. The chapter concludes with a discussion of the Poisson exponential.

Chapter II supplies a convenient summary of results in integral calculus and γ and β functions which are constantly required in statistical theory. Chapter III deals with the Pearson system of curves. The connexion between the Pearson family and problems of sampling from urns is clearly explained. This is followed by a number of more advanced results relating to the normal curve with a brief treatment of the Gram-Charlier series. The joint distribution of two variables and the normal correlation surface form the subject-matter of Chapter IV. Important results are obtained with the help of calculus, and relevant formulæ for tetrachloric correlation are given at the end. Chapter V gives a general treatment of multiple and partial correlation together with a large number of results.

Fundamentals of sampling theory relating to the mean are given in Chapter VI. The treatment is broadly algebraic based on the method of mathematical expectations. The reproductive property of normal law is pointed out and emphasised; and certain algebraic results for moments of non-normal distribution are quoted without proof. This is followed by Tchebycheff's inequality and the law of large numbers. This forms the background for introducing the concept of "null hypothesis", tests of significance, and the significance of a difference in proportions.

The theory of small or exact sampling distribution is discussed in Chapter VII; and the ψ^2 distribution and statistical inference in Chapter VIII. The seventh chapter opens with an algebraic calculation of the expected value of the variance, which naturally leads on to a discussion of unbiassed estimates and the concept of degrees of freedom. This is followed by a discussion of Student's *t-distribution* by analytic methods. Fisher's method of geometrical representation is next explained and used to obtain the distributions of the standard deviation and variance, and of Fisher's t. The structure of analysis of variance is explained in the case of a twofold table as well as its use in testing linear regression. The multinominal law is used as the starting point for the discussion of the ψ^2 distribution.

The second part of Chapter VIII starts with a brief introduction regarding induction and Bayes' theorem on usual lines. This is followed by a concise treatment of fiducial limits with standard formulæ for the mean, difference between two means, and variance.

The last three chapters probably form the most valuable part of the book. Our only complaint is that the author has not gone far enough. The mathematics used is not quite elementary, and the student who understands thus far can be readily trusted with some of the more advanced work in the sampling distributions, and may be taken deeper into modern theories of estimation and of testing of hypothesis.

The appendix in Part II gives five per cent. and one per cent. points for the distribution of the ratio of variance, and also the χ^2-probability scale reproduced from R. A. Fisher's Table.

A large number of exercises and review problems are given in each part. References to published papers and hints for additional reading form a valuable feature. The book abounds in quotations of varying length and importance; these are always enjoyable and often stimulating. In many ways the book is an improvement on text-books of similar scope and aim.

P. C. MAHALANOBIS.

General Physics. By W. L. Whiteley, B.Sc. (Lond.). (The University Tutorial Press, Ltd.), 1940. Pp. viii + 590. Price 7*sh.* 6*d.*

This book represents a course of physics upto the S.S.L.C. standard with emphasis on the practical and technical applications illustrating physical principles. The mathematics required for perusing the book is very limited, only sparing use having been made of simple Algebra and Trigonometry. Illustrative figures and diagrams are plentiful, and the principles underlying many technical applications are briefly explained as often as possible. Illustrative examples are neatly worked out and a large collection of problems is distributed throughout the book. But on account of the large ground covered, the explanations are sometimes too meagre and sketchy. With so many everyday appliances, based on physical principles, which the citizen meets in common life, every educated person ought to possess at least as much knowledge of physics as is contained in this book. We feel that the book is particularly suited for students taking up Diploma courses in technical subjects in which a knowledge of physics is essential.

T. S. S.

Technique of Grassland Experimentation in Scandinavia and Finland. (Herbage Publication Series, *Bull. No.* 28. Published by the Imperial Bureau of Pastures and Forage Crops, Aberystwyth), 1940. Price 2*sh.* 6*d.*

The Technique of Grassland Experimentation is considered under two heads: (1) Quantitative measurement of grass production; and (2) Stock-grazing trials. These aspects are dealt with clearly in seven articles by various workers. The salient points brought out in the bulletin are:

(1) Instead of using permanent, fenced areas, which are expensive, movable "control cages" made from boards and barbed wire, 4×4 m. in size are employed. This method has proved advantageous especially in testing the yield of pasture leys in harvesting hay for winter fodder.

(2) The technique of stock grazing is of great value on large areas which are suitable for large-scale experiments.

(3) Climatic and soil conditions have a great effect upon the results. This point is of importance to India, where divergent climatic and soil conditions are encountered. Experiments on a large scale should be undertaken in various parts of the country in order to obtain results of practical value.

(4) For botanical analyses, the Hult-Serander method is employed. This gives an idea of the covering of each species. The method does not appear to differ from the method of Braun-Blanquet in any essential point. In the experience of the reviewer, this method cannot be applied with any accuracy for Indian grasslands where the number of grass species and weeds is great.

The Bulletin will prove to be a valuable guide to scientists in India engaged on studies relating to our grasslands.

F. R. B.

The Biochemistry of Symbiotic Nitrogen Fixation. By Perry W. Wilson. (The University of Wisconsin Press, Madison), 1940. Pp. xiv + 291. Price $3.50.

Nitrogen is one of the most interesting and important elements intimately concerned in the economy of life processes. It is considered to be an inert element in the sense that it does not enter into combination with other gases like oxygen and hydrogen at ordinary temperatures and atmospheric pressure, and cannot, therefore, be 'fixed' without having recourse to high temperatures and pressures. In nature, however, this fixation takes place in the soil and in plants at ordinary temperatures through the agency of micro-organisms. The fixation that takes place in the bodies of plants is called symbiotic fixation, as it is brought about by micro-organisms to the mutual advantage of the plants and the micro-organisms. This process of fixation is most evident in leguminous plants.

The chemistry of symbiotic nitrogen fixation is a fascinating subject for study and is relatively an unexplored field. In recent years there have been published several papers dealing with the fixation of nitrogen by bacteria and plants,—the biochemistry of bacteria, the mechanism of fixation and the enzyme systems connected therewith. These contributions to our knowledge of symbiotic nitrogen fixation are many and scattered in literature. The author has collected and reviewed these several papers in the publication under review. The book contains eleven chapters. The first chapter contains a discussion on the nitrogen economy of man and nature; the second is a survey of the work on leguminous plants; the next seven chapters deal with the bio-chemistry of the fixation process, while the last two chapters are devoted to a discussion on the practical and theoretical aspects of the subject.

The book is well written and neatly printed, and makes a useful addition to the library on the subject.

B. V. N.

Catalogue of Indian Insects—Part 25. Thysanoptera. By T. V. Ramakrishna Iyer and V. Margabandhu. (Manager of Publications, Delhi), 1940. Pp. 64 + viii. Price Rs. 2–2–0 or 3*sh.* 9*d.*

Till recently very little work on any aspect of this comparatively generalised order of insects in India, had been done. A systematic treatment of this group had been a long-felt want among Indian Entomologists and the authors who have now brought out this volume, deserve their warmest thanks.

The *Catalogue* includes 232 species distributed among 94 genera. The classification adopted by Karny and Watson, has been closely followed by the authors in the arrangement of the different species.

THE RAMAN EFFECT

Scattering of Light and the Raman Effect. By S. Bhagavantam. (Andhra University, Waltair), 1940. Pp. 333 + x; 2 plates and 41 figures. Rs. 15 net.

IT is an old saying that 'good wine needs no bush', and on reading Professor Bhagavantam's volume my first impression is that the work needs no recommendation to the discerning physicist. It commends itself in three ways. Firstly there is the intrinsic interest and great importance of the subject-matter, with which every physicist nowadays must have at least a nodding acquaintance. Secondly there is the obvious need of a book which gives a view of the whole subject, in sufficient detail to be of use to the advanced worker. Thirdly there is the name of Prof. Bhagavantam—a sufficient recommendation in itself. It is well known that Prof. Bhagavantam has himself taken a great part in many of the advances in this field during the past dozen years, and no one is better qualified than he to give a connected account of it.

My second impression is of the great weight of knowledge which lies behind this volume. The scattering of light was at one time one of the by-paths of Physics, interesting in a way but leading nowhere in particular. It has now become a main thoroughfare, a highway which connects many seemingly unrelated subjects. The papers which have been published on the Raman effect alone, since its discovery in 1928, must run into thousands; and for any one person to be aware of all this progress, and acquainted with much of its detail, is itself a considerable achievement. Prof. Bhagavantam shows a scholarly knowledge of a very wide range of published work, and, as far as one who is not an expert in this field is able to judge, he gives a balanced account of the whole. The book is by no means confined to the contributions made in India, important as those contributions have been. Further, the theoretical interpretation of the phenomena is given its due place, and not subordinated to the purely experimental part. Indeed the experimentalist may possibly find some of the chapters rather strong meat; such as XI and XII, which involve some knowledge of tensors and the theory of groups. To extract the nourishment which these chapters contain requires a good mathematical digestion. But even those of us to whom such chapters will inevitably be something of a struggle will welcome them for the development of a theoretical understanding of the phenomena is surely no less important than the phenomena themselves.

My third impression, which only the reading of such a connected account can give, is of the rapidity with which Nature has revealed her secrets in this field. The colour of the sky, and of the sea, must have been one of the earliest natural phenomena to impress itself on the mind of man. But the phenomena which have been longest known have often proved most difficult to understand; lightning and permanent magnetism are obvious examples. No sooner had the classical theory, in the hands of Rayleigh and others, taught us why the sky is blue, than the new developments began. Any comparison of our present knowledge with that of even twenty years ago emphasises the astonishing progress since the time when, with a little theory and a modicum of experimental results, a few pages would have sufficed to give a reasonable account of the whole subject.

The first nine chapters of this book are concerned with ordinary scattering. After a short historical introduction there follows some fairly simple classical theory, and formulæ are deduced which give the intensity and depolarisation of the light scattered by molecules. Chapter IV is a careful account of experimental methods and a comparison of the results with what may be deduced on the simple theory. One may commend Prof. Bhagavantam's wisdom in putting the experimental methods together in this chapter, and again in chapter XV for the Raman effect, so that the experimentalist finds no difficulty in going straight to what he wants. The numerous tables of experimental results which are to be found throughout the book are also to be commended. In chapter V the theory of scattering by dense media is given, followed by another chapter of results. Then come liquid mixtures, and finally a discussion of optical anisotropy and birefringence, and the connection with molecular structure.

Those readers who are chiefly interested in the Raman effect may turn straight to

chapter X. This is an excellent chapter, giving a sort of initial survey of the Raman effect and including several beautiful photographs of Raman spectra. Then comes the theory—more advanced this time—and even the author himself suggests that some of this may judiciously be omitted at a first reading. Some may prefer to take chapter XV, an excellent account of experimental technique, immediately after chapter X. The self-contained character of these chapters makes this possible.

The last three chapters are also of great interest. They deal with the Raman effect as a means for the elucidation of chemical problems. They presuppose, of course, a knowledge of much of the earlier part of the book, but are very readable and largely non-mathematical. They contain a wealth of experimental material. The book ends with seven appendices on mathematical topics.

In a book of this kind there is not much ground for criticism. The experts may differ, as they always do, about the choice of material, but in so vast a field it is clear that selection is inevitable. The ordinary reader would probably have valued a select bibliography, even though the author explains that such have been given elsewhere. The references are actually fairly numerous, but they occur somewhat sporadically in footnotes. An index of the chemical compounds mentioned would increase the value of the book as a work of reference. Compared with the general excellence of the book, these criticisms are of a minor kind. The English throughout is clear and direct, and scarcely anything more serious than an occasional slip in punctuation has been noticed. The printing is in a large clear type on good paper, and there are remarkably few misprints. One curious feature is that each chapter begins on a right-hand page, even though (as at the end of chapter X) this involves leaving practically two whole pages blank.

Every physicist whose work is connected with the scattering of light will want a copy of Prof. Bhagavantam's book on his table, and it should find a place in every Physics library. If the chemists can also be induced to buy a copy, so much the better, for no branch of Physics throws more light on the problems of Chemistry than this. It is on all accounts a book to be warmly welcomed.

H. J. TAYLOR.

REGIME FLOW IN INCOHERENT ALLUVIUM*

DESIGN of non-silting canal sections was first attempted by Mr. Kennedy; based on data collected from Upper Bari Doab Canal he derived the empirical equation $V_0 = 0{\cdot}84D^{0{\cdot}64}$ where V_0 is the critical mean velocity at which a canal neither silts nor scours and D is its depth over a nearly horizontal bed. In 1919, Lindley put forth a relation of bed width to depth of $B = 3{\cdot}80D^{1{\cdot}61}$. Several formulæ of the form $V = C\,D^{n}$ were subsequently introduced satisfying a particular set of conditions with varying values for C and n. According to these formulæ, a given discharge and silt charge uniquely determined depth width, and slope of a regime channel.

Mr. Gerald Lacey's work* on regime flow in incoherent alluvium is of great value to irrigation engineers. In 1930, he proposed the equation $P = 2{\cdot}668Q^{1/2}$ connecting the wetted perimeter of a stable channel with its discharge. Starting with the idea that in a silt transporting channel a constant discharge tends to transport a fixed "regime" silt charge, Lacey concludes that a constant discharge, carrying silt of a given grade and flowing in an alluvial plain of the same grade tends eventually to assume a gradient solely determined by the discharge and silt grade, and that the mean velocity, hydraulic mean depth and wetted perimeter tend to unique determination.

From an analysis of the data from the Upper Doab Canals and Madras-Godaveri Western Delta, Lacey derives the relation $V = c\,R^{1/2} = K^{1}\,m\,R^{1/2} = K\,f^{1/2}\,R^{1/2}$ where f is a silt factor, K a numerical constant, $m = \frac{V}{V_0}$ critical velocity ratio, and R is the hydraulic mean radius. Lacey concludes that $\frac{V}{R^{1/2}} = C$ is a function of the grade of alluvial material transported when the channel is active,

* *Regime Flow in Incoherent Alluvium*. By Gerald Lacey. (Central Board of Irrigation Publication No. 20.), 1940 p. 65.

the material is incoherent, and there is a balance between silting and scouring, the value of c at all times indicating the degree of turbulence and eddying motion in the water. From the Lindley Lower Chenab Branch data Lacey derives the relations $R^{1/2}S = c'$ and $c = 16\ c'^{1/3}$ and from these he gets $V = 16R^{2/3}S^{1/3}$ as the general regime equation.

Lacey further states that the rugosity of a channel or the coefficient of a regime channel flowing in alluvium depends on the average size of the materials of the boundary and introduces what he calls an absolute rugosity coefficient N_a based solely on the average size and density of the transported and moving bed material. $V = 16R^{2/3}S^{1/3}$ written in the form $V = 64\left(\frac{R}{V}\right)^{1/2}\sqrt{RS}$ makes the Chezy coefficient $C = 64\left(\frac{R}{V}\right)^{1/2}$. When V is replaced by $V = K\,m\,R^{1/2}$, C becomes equal to $\frac{64R^{1/4}}{K^{1/2}m^{1/2}}$ which can be written as $\frac{R^{1/4}}{N_a}$ in metric units or as $\frac{1{\cdot}3458}{N_a}R^{1/4}$ in foot units. Kennedy takes the Upper Bari Doab Canal silt with a critical velocity ratio of unity as standard silt. Lacey writes $N_a = {\cdot}0225m^{1/2}$ and takes the standard grade of silt as having $N_a = {\cdot}0225$ when the H.M.D. is one metre. Equating $\frac{64}{K^{1/2}m^{1/2}}$ to $\frac{1{\cdot}3458}{N_a}$ gives K a value of 1·145. To obviate the difficulty experienced in assigning values to the rugosity coefficient, Lacey gives N_a a value appropriate to the bed material and the equation is written as $V = \frac{1{\cdot}3458}{N_a}R^{3/4}(S - s)^{1/2}$ where s is a suitable deduction made from the gross slope to account for the errors in the determination of correct slope and H.M.D. and for the shock encountered due to bends, irregularities and condition of the channel.

From Kennedy's data, Lacey derives the relation $V = 1{\cdot}17R^{1/2}$ and from Kennedy, Madras, and Lindley data he gets $Af^2 = 3{\cdot}8V^5$ where A is the area of the cross-section. From these two equations he gets $P = 2{\cdot}668Q^{1/2}$, or $P = (2{\cdot}668)^2\,RV = 7{\cdot}12RV$. If K is put equal to 1·1547, K^2 becomes $\frac{4}{3}$ and $f = \frac{3}{4}\frac{V^2}{R}$ and $c = 16{\cdot}04557c'^{1/3}$ and $S = {\cdot}0003727f^{3/2}R^{-1/2}$ or ${\cdot}000391\frac{f^{5/3}}{q^{1/3}}$ where $q = RV$, or ${\cdot}000542\frac{f^{5/3}}{Q^{1/6}}$.

Regime Equations

Lacey

$P = 2{\cdot}668Q^{1/2}$

$V = 1{\cdot}155f^{1/2}R^{1/2}$

$R = {\cdot}472\left(\frac{Q}{f}\right)^{1/3}$

$S = {\cdot}000542\frac{f^{5/3}}{Q^{1/6}}$

Punjab Research Institute

$P = 2{\cdot}800Q^{1/2}$

$V = 1{\cdot}120R^{1/2} = {\cdot}767Q^{1/6}$

$R = {\cdot}470Q^{1/2}$

$S = {\cdot}00209\frac{m^{\cdot 86}}{Q^{\cdot 21}}$ (m-diameter of silt particle in mm.)

The two slope equations show that the silt factor and silt grade take the place of a rugosity coefficient and are interrelated; if the power of m is taken to be ·833 it would make the silt factor vary as the square root of the mean diameter of the silt particle.

Crump found on analysis that in stable silt transporting canals the critical velocity ratio is an inverse function of the Kutter's rugosity coefficient. Any rugosity coefficient depends on the grade of bed silt. Lacey on plotting the values of f and m from the Punjab data finds that any correlation between m and f must be of an inverse character.

In perfect regime channels with wetted perimeter consisting of incoherent silt, grade of bed silt can be correlated with turbulence as measured by $\frac{V^2}{R}$ and under such circumstances, turbulence is also a true silt factor. In non-regime channels or channels approaching regime but not free from shock and the Crump effect, the grade of bed silt is a function of gross turbulence in the channel; the gross turbulence, the result of mean forward velocity, agitation of water brought about by shock, and destruction of shock energy, is also measured by $\frac{V^2}{R'}$ where R′ is the altered value of the H.M.D. due to the existence of shock at the section. $\frac{V^2}{R'}$

the measure of gross turbulence is a true silt factor, R′ being greater than R where positive shock is encountered and less than R under exceptional circumstances when there may be negative shock due to irregularities in the channel taking the form of smooth portions of stiff fine clay banks and also possibly smooth rigid patches of the bed; in the latter case with the bed silt fine almost coherent there is no limit to the value assumed by $\frac{V^2}{R'}$; such a channel would have rigid boundaries as a limit and would fall beyond the class of channels under discussion.

Lacey suggests that the silt factor in a channel, free from shock, varies as the square root of the bed silt grade and that f_r will be equal to $km_r^{1/2}$ for silts of equal coherence, suffix r indicating regime conditions. When there is shock the measured values of m and f determine shock and the products $m_r^{1/2}f_r$, $m^{1/2}f$, $m'^{1/2}f'$ are all equal; the silt factor far from varying directly as the square root of the bed silt diameter, varies inversely as the square root. In the Punjab data, shock is so important a factor that variations in silt grade are often traceable to this source. $f_r = m^{1/2}f$, and $f_r = km_r^{1/}$ yield $m^{5/6} = \left(\frac{f_r}{f}\right)^{5/3}\left(\frac{f_r}{k}\right)^{5/3}$.

The 'Bose-Malhotra' slope equation $S = \cdot 00209\frac{m^{\cdot 86}}{Q^{\cdot 21}}$ being an empirical relation partially compensates for shock. Shock in such channels transporting silt, perfectly incoherent or of constant coherence, will be indicated by a departure from regime slope and a corresponding departure from normal bed silt. Lacey modifies this relation to $S_b' \propto \frac{m^{5/6}}{q^{1/3}}$ and finds from the Punjab data, that $S_b' = \cdot 0010002\frac{m^{5/6}}{q^{1/3}}$ which can be written as $\frac{\cdot 0010002}{k^{5/3}} f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$ where k should be equal to 1·1775 to suit the Punjab data. S then becomes $\cdot 000385 f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$. When $k =$ 1·760 S becomes $\cdot 000391\, f_r^{5/3}\frac{\left(\frac{f_r}{f}\right)^{5/3}}{q^{1/3}}$ and this becomes identical with Lacey's slope equation $S = \cdot 000391\frac{f^{5/3}}{q^{1/3}}$ when there is no shock.

Lacey finds that the equation fits the Punjab data well and concludes that it is applicable to regime channels transporting sandy silt of standard coherence, thus introducing a coherence factor for the majority of the Punjab observations as unity. For silts of the same degree of coherence $f_r = k'm_r^{1/2}$ where $\frac{k'}{1\cdot 76}$ is the coherence factor for the silt and the modified equation of Bose is written as $S_b' = \cdot 0010002\left(\frac{k'}{k}\right)^{5/3}\frac{m^{5/6}}{q^{1/3}}$ where $\frac{k'}{k}$ is a coherence factor and $S = \cdot 000391\,(k')^{5/3}\frac{m^{5/6}}{q^{1/3}}$ when k is taken equal to 1·760.

In the Punjab data there are five discordant channels of small discharge, for these channels it is found from the tabulated values that ·001311 replaces ·0010002 thus making $(K')^{5/3}$ ·000391 equal to ·001311 giving k' a value of 2·07, and the coherence factor a value 1·175; and in the case of the five large discordant channels k' becomes 1·894 and the coherence factor 1·075. In the case of the small channels the silt factor is relatively high and the bed silt grade low, but high slopes are required in spite of the silt being fine as a result of increased internal friction of fine silt due to its coherence. In the case of the five large channels assumption of a high silt charge increasing coherence renders them concordant.

Bose's modified equation $S = \cdot 0010002\frac{m^{5/6}}{q^{1/3}}$ applies equally well whether shock is present or not; shock is implicit in the equation and silt is of uniform coherence with a silt factor constant $k = 1\cdot 76$. When no shock is present Lacey's equation $S = \cdot 000391\frac{f^{5/3}}{q^{1/3}}$ is applicable whether the coherence varies or not, coherence being implicit in this relation.

To eliminate the effects of variations of kinematic viscosity, Dr. Malhotra gets from Lacey's equations for silt factor, the relation

$V \propto \left(\frac{R}{m}\right)^{1.2} (gRS)^{1.2} S^{1.2}$, in this relation kinematic viscosity being implicit as $\frac{R}{m}$ is a function of the temperature of water. Lacey writes this in the form $\frac{V}{V^*} \propto \left(\frac{RS}{m}\right)^{1/2}$ (where $V^* \propto \sqrt{gRS}$) to express regime flow in incoherent alluvium.

Mr. Gerald Lacey's work is a valuable contribution to the understanding of regime flow in alluvium and is a stimulus to further research on the subject.

C. GOPALAKRISHNAN.

SOME PRACTICAL RESULTS OF SUGARCANE RESEARCH IN INDIA

THE IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH represents perhaps the most important outcome from the recommendations of the Royal Commission on Agriculture in India (1926) and the renaissance of the Indian Sugar Industry is possibly the most tangible achievement of that Body. The sugarcane position in India at the time of the founding of the Imperial Council of Agricultural Research in 1929 was such as to enable that Council to recommend to Government certain very important steps both by way of tariff protection to the industry and the proper organisation of sugarcane research in India for rehabilitating it. The Council acted both quickly and effectively.

The result is seen in India passing from the position of a major sugar importing country to the present one of surplus production and consequent search for export facilities. Certain of the recent troubles from the sugarcane belt of North India reported in the Press and from the platform are attributable to this very rapid but somewhat ill-planned development of our sugar industry during the last decade. The renaissance of the Industry has shown, however, that Indian capital is by no means shy when suitable avenues are open to it.

In the field of cane research a chain of experimental stations covering all the important cane areas has come into being, financed wholly or partly from the Council's funds and we have before us a publication* of the Council summarising practical results from such work upto and inclusive of 1937–38. Though the results now available are almost three years old, a brief resume of the salient features is here attempted as likely to be of considerable general interest in view of the stress now being rightly laid on the industrial development of our country as a necessary precedent to full development in other directions, economical, social and even political. The publication before us is of such practical utility that the public will be entitled to look forward to similar periodical publications in the future.

The publication includes a bird's eye picture of the history of sugarcanes in our country with a brief description of the Indian indigenous canes which were once in cultivation over the bulk of sugarcane India (mainly sub-tropical). While a low acre yield appears to be their characteristic feature, a fair amount of resistance to the rather difficult conditions of sub-tropical India has been their saving quality. This latter quality would appear to have been partly incorporated in the new Coimbatore productions "Co. Canes" through a somewhat complicated scheme of hybridization.

Brief notes are given of the characteristics of the more important of the new canes. Though the bulk of such are Coimbatore productions which are apparently the most widely cultivated, a few seedling canes from Mysore and foreign countries are also included. The utility of importations from foreign countries like Barbados, Java and Mauritius, would appear to have been mainly in tropical India like Madras and Bombay and also parts of Bengal. A brief indication is also given of types which at the time were considered promising and we gather that certain of these are steadily gaining ground as anticipated.

The report opens with a picture of the recent change in the varietal position

* *Miscellaneous Bulletin* No. 34 of the I.C.A.R., Manager of Publications, 1940, pp. 41, price Rs 1-8-0 or 2*sh*. 3*d*.

province by province. It is seen that in certain provinces like the United Provinces and Bihar, the new Coimbatore productions have covered 90 per cent. or over of the cane areas. In the Punjab over 30 per cent. of the area is yet under an indigenous cane which possesses certain special features that suit the extremely unfavourable conditions for cane growing in that province. The position of varieties in provinces of lesser importance, like Bengal, Bombay, Madras and Assam, is also reviewed. In the Mysore State about 50 per cent. of the area is said to be occupied by a cane HM. 320 bred from a Research Station in the State. This cane as well as a few others of the same origin have spread to parts of Bombay as well.

Section 3 covers, what may be termed, the agricultural aspect of the sugarcane industry and is full of useful informations on various aspects of cane culture, such as, planting, interculture, rotation, manuring and irrigation.

This section starts with a record of the increased yields obtained as a result of the introduction of improved canes coupled with improvements in agricultural practices. The results show in some cases an increase of 50 per cent. and over in the sub-tropical sugarcane belt and in large-scale plantation conditions. The breeding of tropical types was initiated at Coimbatore a decade and a half after its founding, the breeding for sub-tropical conditions occupying its entire attention before this period. This was because of the comparatively larger area (over 80 per cent.) in the sub-tropical belt. We learn that the results of breeding from the tropics are quite equal to that originally recorded in the sub-tropical regions.

When the chain of sugarcane stations was started in the beginning of the last decade, definite improved methods of planting and manuring were available as a result of the work of the various departments of agriculture in India. Three such well-known methods were (1) Shahjhanpur, (2) Pusa, and (3) Manjri methods. The Testing Stations, after carefully experimenting with these methods, were able to record important improvements on them both by way of increasing tonnages and lessening costs of cultivation. Every sugarcane planter, large or small, would do well to study these improvements with the object of utilising them, if possible, to his conditions. Germination is important in cane growing and the report records useful advances both in optimum seed rate and treatment of planting material.

The manurial experiments which include both time and quantity, as well as relative efficiency of different mixtures, have great practical value. Whereas in certain parts of tropical India 150 lbs. of nitrogen together with green manuring is found to be the optimum, the quantity in terms of nitrogen values is appreciably less for sub-tropical India where the corresponding figure is sometimes as low as 60 lbs. The difference between sub-tropical and tropical conditions is further brought out in the case of phosphoric acid application which, while giving some response in Bombay, shows little effect in the Punjab or the United Provinces. It is interesting to be told that dressings of potash definitely increases the rind hardness of cane in the United Provinces which shows that it might be possible to play on the constitution of a plant like the sugarcane through careful soil treatment.

Besides the above, there are other useful results recorded in the publication. Marked advantage has resulted from the introduction of the green manure crop into the rotation both in Bombay and in the United Provinces. The irrigation experiments have tried to find out the minimum quantity on which canes could be grown without affecting gur qualities. The publication finishes with the results of investigation on soil types, pests and diseases, and the various factors affecting cane growth. The publication is priced Rs. 1–8–0 and one wishes it were priced distinctly lower economising in the wrapper and binding. Certain similar publications from the U.S.A. are distributed to agriculturists free or at nominal cost.

"SUGARCANE GROWER".

OBITUARIES

SIR FREDERIC BANTING

BY the death of SIR FREDERIC BANTING, the famous discoverer of Insulin, in a plane crash in Goose Bay, Newfoundland, a great personality has been lost to the world of Science. It is reported that this most unfortunate incident occurred while he was flying, with three others on a very important scientific mission to Britain. The New York correspondent of the '*News Chronicle*' has given further details of this mission. Dr. Banting, it appears, was flying to Britain to demonstrate a new gas defence method he had perfected in collaboration with chemists and physiologists of the University of Toronto. It is to be regretted that he has not lived to see the benefits of his labour in this respect.

Frederic Banting was born at Alliston, Ontario, on the 14th November 1891, and had his medical education at the University of Toronto. Even before he obtained the M.D. Degree in the year 1922, he was lecturing on Physiology at the Western Ontario University at London and thereafter on Pharmacology at Toronto University. Within a period of two years of his graduation, he was appointed Professor of Medicine at the very early age of 32 years.

The researches on the role of pancreas in carbohydrate metabolism attracted the attention of Dr. Banting even while he was a student for the M.D. Degree. In the year 1921 and 1922, Banting and Best succeeded in preparing physiologically active extracts of the pancreas. These extracts were found to inhibit glycosuria and hyperglycemia in depancreatized animals and to alleviate the symptoms of diabetes mellitus in human beings. From a critical study of the existing literature it became apparent to Dr. Banting that in order to prepare active extracts from the pancreas, it was necessary to circumvent the destructive action of the pancreatic enzymes on the hormone. It had been shown previously that the Acinar enzyme secreting cells degenerate more rapidly than the hormone secreting islands of langerhans. The brilliant idea of ligating the pancreatic ducts of dogs and keeping the animals for a period of several weeks to allow the Acinar tissue of the pancreas to degenerate, is entirely credited to Dr. Banting although the work was done in the laboratory of Dr. Macleod, the co-discoverer of Insulin, who was at that time the Professor of Physiology at the University of Toronto. The potential possibility of such a procedure was fully taken advantage of and the brilliant efforts of Banting, Best, Collip and Macleod in this direction, culminated in the successful achievement of the goal. A record of the development of these investigations is given by Banting.[1,2] Patents for the manufacture of Insulin were taken out by the Insulin Committee of the University of Toronto, to whom Dr. Banting and his co-workers made over the process discovered by them. Since this epoch-making discovery, Dr. Banting continued his investigations on the nature and effect of Insulin which is of very great importance in the treatment of diabetes.

The discovery of Insulin, its isolation and therapy is one of the greatest landmarks in modern medicine. This is regarded as one of the biggest contributions of the twentieth century for the alleviation of human suffering. Honours and awards came to Dr. Banting freely from Scientific Bodies and Universities from all over the world. He was awarded the Gold Medal and the Reeve Prize of Toronto University in 1922. In 1925, the Canadian parliament voted him an annuity for life, while in the same year, Toronto University established an amply endowed Institute for medical research known as the Banting Institute. In the year 1923, he was awarded the Nobel Prize for the discovery of Insulin jointly with Macleod.

I had the pleasure of meeting Sir Frederic Banting for the first time in September 1939, at Toronto, where I had been working as a Vincent Massey scholar. I felt at once that he was somewhat out of the ordinary run of scientific men. He was known as a great figure in science, but he could have been equally great at almost anything else.

Immediately after the declaration of War, he was appointed the head of medical research for War, by the Canadian Government. Under his inspiring leadership, a

[1] *Canad. Med. A. J.*, 1926, **16**, 221.
[2] *Edinburg Med. J.*, 1929, **1**, 1.

method of preparing concentrated serum and its application in war wounds was perfected. Simultaneously the investigations on antidotes for poison gas were being carried out in the various scientific laboratories in the University. Dr. Banting must have scored a success in his spectacular work on the new gas defence method. This work is as great as his discovery of Insulin. The new formula has been made known to others and it will therefore be available. Mr. Mackenzie, President of the Canadian National Research Council, is reported to have made the statement that the story of this discovery is a great one and will be told after the war.

Besides being a sympathetic teacher, Dr. Banting was a delightful colleague. All those who have had the pleasure of association with him will cherish his memory with affection and admiration.

N. K. IYENGAR.

SIR SHAH MOHAMMAD SULAIMAN

THE news of Sir Shah Sulaiman's passing away came as a shock to the whole country. But perhaps no one was shocked more than those (of whom the present writer is one) who had enjoyed his overwhelming hospitality just before he fell ill, and who had seen him only three weeks ago taking the most active part in the annual session of the National Academy of Sciences, India, of which he was the President. It is heart-rending to think that he has been snatched away when his mental faculties were at their zenith, and when he was making valuable contributions to human knowledge. His countrymen and others would mourn his irreparable loss for a long time to come!!

Shah Mohammad Sulaiman was born in Jaunpur in 1886. After an exceptionally brilliant school and college career at Jaunpore and at Allahabad, he proceeded to England in 1906 with a State scholarship and joined Christchurch College, Cambridge. He took the Mathematical Tripos in 1909, and the Law Tripos in 1910. That he was no ordinary student pursuing only the prescribed course, is proved by the fact that he had pondered deeply over the prevalent theories of matter and light, and had made notes of his "ideas about radions" which he developed into a coherent theory twenty-five years later. He was also called to the Bar in 1909, and obtained the LL.D. of Dublin in 1910. Returning to India, he joined the Allahabad Bar, and had such a distinguished record that he was offered a seat on the Bench at the unusually early age of 34. In 1929 he was appointed the first Indian Chief Justice of the Allahabad High Court when still comparatively young. When the Federal Court of India was created in 1937, his was an obvious choice for one of the two posts. His work there elicited praise and admiration not only from his colleagues but also from the celebrated English jurist, J. H. Morgan. His was a meteoric rise, and it is not difficult to imagine what further heights he would have attained if he had been spared a little longer. He had an equally phenomenal career as a Scientist. He appeared suddenly and most unexpectedly on the scientific horizon, shone with an ever-increasing lustre for an all too brief period, gained some recognition, and disappeared just as suddenly.

In spite of his being engrossed in the heavy duties of a lawyer and a judge, he took a keen interest in educational matters, and did a great deal for the education of his people. He was a member of the court and academic committees of several Universities and presided over various educational conferences of an all-India character. He was invited to deliver the Convocation addresses of the Agra, Aligarh, Dacca and Osmania Universities. For a number of years he was Vice-Chancellor of the Muslim University, and discharged the exacting duties of his office up to the time of his death. Though his enthusiasm sometimes carried him too far in trying to model the working of the Institution according to his ideas, the whole nation owes him a heavy debt of gratitude for the sacrifice of an immense amount of his time and energy in the cause of education which was so dear to his heart.

All this by no means exhausted his capacities. His energy and vitality knew no bounds. He was a versatile reader, and his library contains one of the finest private collections of manuscripts and books to be found in the country. The present writer had an opportunity of seeing in his possession about a hundred rare Arabic and Persian manuscripts on mathematical and

scientific subjects. He was thinking of editing the most important among these and of having them published. We hope that his family would see their way to having his dream realised. It would be a fitting tribute to his glorious memory.

For the last several years in the midst of his multifarious activities he still found time to do creative scientific work, and he had gradually acquired a more intimate knowledge of modern theoretical physics than many a professional physicist. He had never lost the enthusiasm for this science acquired in his Cambridge days, but it was only in 1933, a quarter of a century later, that he could find time to develop his ideas. Though in this long absence from the field of science he had lost touch with modern developments, it should be remarked to his great credit that he made up the deficiencies very soon. There is a world of difference between his early papers, which were rather amateurish, and his later ones which bear the stamp of a recognised scientist. Such examples are indeed rare in the history of science.

To be able to appreciate his work properly, one must keep in mind the fundamental difference between two schools of thought in the philosophy of to-day. According to the classical school "the purpose of science is to explain the unfamiliar experience in terms of the familiar one by means of the visual images or models". The modern school believes that the explanation of natural phenomena on the atomic scale and the cosmic scale cannot be forthcoming in terms of crude mechanical models of the nineteenth century, and that mathematics is the only tool to deal with the abstract concepts of modern physics. Sulaiman belonged to the classical group, and condemned in strong terms the modern tendency of "accepting such artificial mathematical devices not capable of any real physical significance" and of making ourselves "slaves of mere mathematical symbols". He characterised the current philosophy of knowledge as a "counsel of despair" and an "attitude of defeatism". He believed that "the explanation of the physical world by means of models is important not only for science itself, but also for the general progress of mankind". He was convinced that such an explanation is attainable. Unfortunately for him, the majority of theoretical physicists to-day belong to the second group. This is one of the reasons why his ideas did not find general acceptance among scientific circles, though a few workers here and there agreed with him.

He was a rebel against all authority, and against the "blind faith in the new methods" required of a modern student. He had set himself the task of making a "complete exposure of the various inconsistencies underlying the modern theories", in the hope of inducing the younger generation of scientists "to examine for themselves the full implication of modern postulates". It is quite possible that his open revolt may help to bring about a modern renaissance, just as the revolt against the authority of Aristotle and the Greeks brought about a renaissance of the seventeenth century.

His method was the method of systematic doubt, and like Descartes he began by doubting every axiom on which modern conceptions are based. He questioned the appropriateness of almost every hypothesis about matter and radiation put forward by Newton, Huygens, Maxwell, Planck, Einstein, Bohr, de Broglie, Heisenberg, Schrödinger and Dirac, and rejected them all one by one. But he was not unaware that it is easier to make destructive criticism than to offer constructive suggestions. He submitted alternatives for the two great theories in modern physics, *viz.*, the relativity theory and the quantum theory.

He criticised Newton for assuming (1) that gravitation had an instantaneous effect, thus implying that its velocity was infinite, (2) that the same law of gravitation applied to two bodies whether they were at rest or in relative motion. He criticised Einstein for (1) denying the absoluteness of space, time and motion, (2) making the velocity of light absolute, independent of the motion of observers, (3) giving to space curvature and other properties, (4) making space finite and yet making its finite limit incapable of being attained, (5) denying reality to force and making it a property of space, (6) for introducing a cosmical force of repulsion with the consequent expansion of the universe. He was of opinion that Einstein's "apparently unconvincing assumptions" would not have been accepted if the relativistic equations were not believed to have been confirmed by observation in three remarkable instances, *viz.*, (*a*) the deflection of light from a star when passing close to the sun, (*b*) the displacement of the fraunhofer lines, and (*c*) the advance of the

perihelion of Mercury. Sulaiman challenged these alleged verifications. He quoted recent observational data to show that in each of these three cases there was a glaring discrepancy between Einstein's value and the observational value. He therefore found no justification for accepting "the extraordinary hypotheses on which relativity is founded". Against this, he tried to show that "the ordinary principles of dynamics when applied to moving bodies, themselves yield modified forms of equations which, as a first approximation, reduce themselves to Newton's forms; and as a second approximation to Einstein's form" thus restoring Newtonian Mechanics "to the eminent position it occupied before its dethronement by relativity". He believed that he had succeeded in obtaining such modified equations. This is where the present writer differed from him, and argued with him several times. Obviously, his criticism of the existing theories was to a great extent justified, but it was difficult to see that his own theory was a better substitute, or that his methods were quite acceptable. That, however, is another story.

Sulaiman based his new theory on the assumption that gravitation was an internal action, and not due to any extraneous force acting at a distance. At first he assumed that light consists of material particles called radions which are radiated from surfaces of bodies, and that there are still finer particles called "gravitons" which emanate from the entire mass but are at present beyond the range of our perception. Later on, he gave up this idea of gravitons, and assumed simply that the effect of gravitation is propagated with a finite velocity D, which is nearly constant, and which is equal to the velocity of light. By four different methods he obtained the polar differential equation for the path of a planet, which, he believed, included Newton's and Einstein's equations, and yielded better results than these in the three cases mentioned above. He claimed that neither Newton's nor Einstein's theory can explain an increase of semi-major axis and eccentricity of Venus, Earth and Mars nor a decrease in the case of Mercury and that his own theory not only could explain this, but the sign predicted by his formula agrees with Newcomb's observations, as admitted by Dr. R. Hamilton.

He considered it a crucial test that according to his theory the spectral shift of light from the sun would be $(1+\sin^2\alpha)$ times Einstein's value, where α is the angle between the line of sight and the radius of the sun, giving just double of Einstein's value at the limb. According to *Nature* (1937, 140, 13), Dr. Royd's observation with the correction pointed out by Dr. Evershed shows that "the displacement at the limb was twice the predicted Einstein value". Sulaiman claimed this to be a "cent per cent. confirmation" of his prediction.

He had finally come to adopt the position that even if there are flaws in his physical theory "the law of gravitation

$$-\frac{\mu}{r^2}-\frac{3\mu h^2}{D^2}\frac{1}{r^4}$$

propounded by him, can be taken as an empirical law giving correct values" in the cases mentioned above.

Like J. J. Thomson, Sulaiman was a non-believer in the quantum theory, because, as he believed, it gave rise to a "dilemma in physics", *viz.*, the fact that matter and light could be neither purely corpuscles nor purely waves. To him the idea was philosophically repugnant that they could be both corpuscles and waves. His very last paper, *viz.*, the address delivered at the Delhi Session of the National Academy of Sciences, makes a searching analysis of the whole question, and points out the unreal character of modern physical theories. He sets out to restore reality to nature, and removes the fallacies that there can be any waves without a medium, and that the phenomena of interference and diffraction cannot be explained on any corpuscular hypothesis. As the belief in a medium is demonstrably untenable, he rejects the wave theory altogether and retains only the corpuscular theory of light as well as of matter. But his light-corpuscles are not just the light particles of Newton or the light-quanta of Einstein. For him "light is a binary corpuscle, consisting of one positive and one negative charge, rotating round each other under their mutual force of attraction, the whole system moving forward with high velocity". He has published the mathematical development of this Rotational or Binary Theory as Chapters XIV and XV of his "Mathematical Theory of a New Relativity" published in the various numbers of the *Proceedings of the National Academy of Sciences*, India, between 1934 and 1940. In

these papers he has tried to deduce almost all the fundamental results of modern quantum mechanics. Naturally, it will take some time to analyse his work and find out how far his claims are justified.

His work earned him a considerable reputation, and he was the recipient of several honours. The editors of *Nature* (11th May 1935, p. 797), *Science* (16th and 30th November 1934) and *Science News Letter* (1st December 1934; March 1935) wrote encouraging reviews of his theory, and some scientists of renown made appreciative remarks about it. He was awarded the Honorary Degree of D.Sc., elected the Vice-President of the *Calcutta Mathematical Society*, Fellow of the *National Institute of Sciences*, India, and President of the *National Academy of Sciences*, India.

It remains an acknowledged fact that there is a serious crisis in the foundations of modern physics. Sulaiman's ambition was to formulate a rational and unified theory of physical phenomena. Even if he has not succeeded—and it must be remembered that he did not have much time to develop his ideas—it cannot be denied that he did a great service to modern science in focussing our attention on the glaring anomalies in existing theories!

RAZIUDDIN SIDDIQI.

ADVANCE OF EDUCATION ON THE FRONTIER

THE schools are slowly coming to be accepted as a feature of life in North Waziristan and the village schoolmaster is beginning to be regarded as having other uses besides falsifying the dates of births and deaths.

In North Waziristan education has to contend with the fanatical opposition of hostile elements. In October 1939, they kidnapped an old and devout Muslim, a teacher in the Miranshah middle school, and stabbed him in the back. Unsettled conditions have made the inhabitants reluctant to take responsibility for the protection of school buildings, so that four schools have to be housed in hired buildings at unnecessary expense. The eight primary schools, like the middle school, are in the relatively settled revenue-paying areas in or near the valley of the Tochi river.

The newly re-opened school at Spalga, however, attracts a few Wazirs as well as Daurs. In 1939–40 two thousand rupees were distributed in scholarships. The schools held an athletic meeting at Miranshah followed by an entertainment given by the boys. A large number of outsiders attended and immediately petitioned for a high school. The middle school also gave an amusing play at the New Year celebrations.

In the South Waziristan Agency there are lower middle schools at Kaniguram, Ladha, and Kotkai, and five primary schools. The number of pupils has increased appreciably, and there is a keen demand for educational facilities. In 1939–40 five thousand rupees were sanctioned for scholarships. A lot of boys, chiefly Mahsuds, go to the Church Missionary Society's High School at Dera Ismail Khan where Dr. Iliff is running a boarding-hostel for these tribal pupils. Many of the best families send their sons to this school, where attention is paid chiefly to character-building, and the results being achieved amongst the Mahsuds call to mind the progress made amongst the Kashmiris by Canon Tyndale-Biscoe.

The demand for education in the Malakand Agency far exceeds the facilities available. There is a High School at Thana, a lower middle school at Dargai and fourteen primary schools. In Swat State, there is an anglo-vernacular middle school at Saidu. In Chitral State, the primary school at Chitral has been raised to the middle standard and a large new school building has been constructed. There are eighteen schools in all.

INDIAN SCIENCE CONGRESS, BENARES, 1941

Summaries of Addresses of Presidents of Sections

7

ZOOLOGY

President: PROF. A. SUBBA RAU

SOME ASPECTS OF MAMMALIAN PLACENTATION

HARVEY (1657) regarded the placenta as an organ which elaborated from the maternal blood the food required for the development and growth of the fœtus, while Mayow in 1674 considered that it performed the function of a fœtal lung. The view that the maternal blood circulated through the placenta was put forward by John and William Hunter. We owe to Jenkinson (1913) the view that the placenta is the organ in which the blood vessels of the embryo are brought into intimate anatomical and physiological relation with the spaces in which maternal blood is circulating. Placentation was defined by Otto Grosser (1910) as the intimate junction of the mucosa of the uterus with the chorion for purpose of exchange of material between the mother and the offspring. Professor Hill emphasised that the placenta was a composite structure partly maternal and partly fœtal, the two being either in simple apposition or intimately blended, but in no case with an admixture of fœtal and maternal blood streams. Normal mammalian placenta, in the words of Masoman, is an apposition or fusion of the fœtal membranes to the uterine mucosa for physiological exchange.

The yolk-sac placenta except in the native bear and the wombat is usually of transitory functional significance. The Eutherian mammals have allantoic placenta. The placenta was formerly distinguished as diffuse, multiplex, zonary, cotyledonary or discoidal according to its external appearance. Weber, Huxley and Strahl based their classification on the presumption that in certain forms there was loss of maternal tissue during parturition. Caducous or non-caducous (Weber), deciduate or non-deciduate (Huxley), Placenta vera or semi placenta (Strahl). Assheton divided the Placenta into placenta cumulate and placenta plicate, based on the activity of the trophoblast. Otto Grosser's classification, however, into four types based on the exact relations of the maternal and fœtal tissues has general approval: epithelio-chorialis, *e.g.*, pig; syndesmo-chorialis, *e.g.*, sheep; endothelio-chorialis, *e.g.*, carnivores; hæmo-chorialis, *e.g.*, Rodentia, Insectivora, Cheiroptera, Anthropoid Apes and Man. Some maintain that the epithelio-chorialis type is primitive and the hæmo-chorialis is highly specialised while others regard the latter as the primitive type. Both views have facts to support, but the former view is more probably the correct one. The number of layers of cells that separate the two blood streams progressively decreases from six in epithelio-chorialis to three in hæmo-chorialis. The endothelium of the maternal capillary, the connective tissue around it, the uterine epithelium, the trophoblastic epithelium, the connective tissue of the allantochorion and the endothelium of the fœtal capillary represent the six layers in the epithelio-chorialis type. In the syndesmo type the uterine epithelium is lacking; in the endothelio type the fœtal connective tissue is also lost; and in the hæmochorialis the maternal capillary endothelium disappears in addition to the above two.

In the fallopian tube the fertilized ovum depends on the secretion of the surrounding tissues for its nourishment. In the uterus, till it attaches to the uterine wall, it is nourished by uterine secretions; with the establishment of the placenta, it depends on direct absorption by the trophoblast of the products of the uterine mucous membrane; and with the vascularisation of the allanto-chorion, on the maternal blood.

The proteins are transferred as amino acids to the fœtal blood; the exact nature of the amino-acids has yet to be worked out satisfactorily in the different types of placenta. The glycogen store of the mother is the chief source of carbohydrate for the fœtus. The leucocytes of the maternal part of the placenta seem to play a part in the transference of fat, these loaded with fat migrating into the fœtus. In the human placenta the fats may either pass across the placental barrier to the fœtal blood or may be absorbed by the maternal placenta from its blood stream and passed on to the fœtal blood with or without modification. Further work on the function of the placenta as a judicious regulator of fat supply may promise fruitful results, as the fat content of the placenta is stated to decrease with age. Work on placental enzymes is also needed. Our knowledge of the role of vitamins other than that of "E" is meagre, as also of the mineral metabolism.

The fœtal hæmoglobin differs from that of the mother in the few forms that have been recently examined. The studies of Boor and Hektoen indicate that the carbon monoxide hæmoglobin is species specific. Further, the blood of different animals show both qualitative and quantitative differences in their hæmoglobin. The metabolic needs of the embryo and accordingly the oxygen requirements vary in different species of mammals. The physico-chemical properties of the placental barrier in different groups of mammals with reference to the rate and intensity of exchange of materials await satisfactory solution.

The subject of nutrition of the pregnant mother may well form the subject of serious research in the newly established ante-natal clinics in Indian Maternity Hospitals. The attention of the Nutrition Research Laboratories may also be directed to the study of fœtal nutrition. Indian zoologists may in future turn more and more to experimental methods in their investigations. A co-operative effort by

zoologists, physiologists, specialist medical men, and biochemists is needed in a well-planned study of fœtal nutrition.

S. G. M. R.

3

CHEMISTRY

President: PROF. MATA PRASAD

PHYSICO-CHEMICAL STUDIES OF GELS

THE gels may be broadly classified as organic gels, inorganic gels and inorgano-organic gels, the classification being based upon the nature of the gel-forming material. The organic gels are obtained usually by preparing a hot solution of the material in a suitable solvent and cooling it down until it sets. In some cases, mere heating with a suitable solvent is sufficient to bring about the gel formation. Change of solvent is again helpful in the preparation of certain gels. Amongst the inorgano-organic gels, we have the soap gels studied by McBain and co-workers. It has been shown by the work at the *Royal Institute of Science*, that good, transparent, colourless gels of many soaps could be obtained in pinene; these gels showed syneresis and were found to be heat reversible. Inorganic gels have been produced by (*a*) mixing the constituents of a gel-forming mixture, (*b*) by the addition of electrolytes to a solution and (*c*) by the change of solvent.

The composition of the gel-forming mixture has a profound effect on the properties of the gel formed. This aspect has received considerable attention at the laboratories of the *Royal Institute of Science* and has led to the preparation, in a transparent state, of a number of gels which were originally known only in an opaque or translucent condition.

The kinetics of the formation of gels has been the subject of numerous investigations. The methods of (*a*) Flemming, (*b*) Fells and Furth, (*c*) Hurd and Letteron, and (*d*) Prasad and Hattiangadi, for determining the setting time, are found to yield different values for the same gel-forming mixture. The methods are however, useful for a comparative study. Effect of temperature on the setting time has been investigated by Hurd and co-workers. They are led to consider that the setting of a gel is an activated process. Prasad and co-workers found that heat reversible gels are often associated with a negative heat of activation. The effect of concentrations of reactants, pH, electrolytes and non-electrolytes on the rate of setting has been studied with several gel-forming systems. Prasad and co-workers have contributed considerably to our knowledge in this field. They have followed up the setting process by measurements of viscosity and intensity of transmitted light. The latter technique has now been perfected by Gogate working at the *Royal Institute*. Subbaramiah has followed up the process of gelation by measuring the depolarisation factors, ρ_v, ρ_u and ρ_h. His results are in general agreement with the accepted ideas regarding the process of gelation.

Gels exhibit many interesting properties. Certain class of gels become solutions on being mechanically agitated and set into gels again on standing. This phenomenon known as thixotropy has been investigated by several workers. Special mention is to be made of the work of Goodeve and co-workers, who have devised a viscometer which permits of a continuous alteration of the rates of shear. Prasad and co-workers have observed "Zonal" changes of viscosity during the gelation of thixotropic gels.

Systematic work on the elastic properties of inorganic gels has been carried out by Prasad and by Yajnik and co-workers. The vibration of the free gels has been studied by Prasad. The vibration of containers containing set gels has been studied by Holmes and co-workers.

The phenomena of syneresis and swelling or inhibition has been investigated by several workers, as also the drying of jellies.

Considerable amount of work has been done on the sorptive properties of the dried gels. Recent work of K. S. Rao on hysterisis in sorption has established the correctness of the cavity concept proposed by McBain for explaining hysteresis. The cavity idea fully explains the phenomena associated with the scaning of the hysteresis loop as well as the drift and the disappearance of the loop.

The structure of jellies has been investigated by a number of workers. "The fibrillar theory is in harmony with most of the characteristic properties and varied phenomena shown by gels. It explains satisfactorily the elasticity, viscosity, syneresis, swelling, dehydration and hysteresis diffusion and optical and ultramicroscopic phenomena. This theory has the adherence of most of the workers on the subject of gels although it cannot be assumed *prima facie* that all gels have the same architecture."

K. S. GURURAJA DOSS.

4

GEOLOGY

President: DR. M. R. SAHNI

PALAEOGEOGRAPHICAL REVOLUTIONS IN THE INDO-BURMESE REGION AND NEIGHBOURING LANDS

Vindhyan to Devonian

IN his Presidential Address to the Geology Section, Dr. M. R. SAHNI deals with the Palæogeographical Revolutions in the Indo-Burmese Region and neighbouring lands during the Vindhyan to Devonian period. To use his own words, he has attempted to give us "a panoramic review of the sequence of geological events that have moulded the palæogeographical history of the Asiatic continent, and more particularly of the Indo-Burmese

region" during this period. Such a review has naturally to be based almost entirely on a comparative study of the rocks and fossils of this period in different areas—the only basis of exact correlation being the occurrence of identical species of animal or plant fossils in strata of marine or continental origin as the case may be. Whenever there is a difference in the character of the marine faunas of a period between two adjacent areas, the usual tendency is to interpolate a land barrier; but as Dr. Sahni has pointed out, this is not always correct since "variation in the physical conditions such as temperature, depth, relative salinity, direction or strength of ocean currents of intercommunicating marine regions may be just as effective barriers to the migration of marine faunas, as land barriers". He also reminds us that "such differences may also be due to the fact that we are not dealing with strictly contemporaneous faunas, but with faunas of varying ages within the same geological system."

After drawing our attention to these aspects of the problem which we have to bear in mind while dealing with palæogeographical studies, Dr. Sahni proceeds to deal with the subject proper of his address and gives an account of the land and water connections which existed between India and the adjacent countries at different periods between the Vindhyan and Devonian times, in the light of the most recent palæontological studies made in these different areas. Some of his main conclusions are (*i*) "a correlation between the Vindhyans and Cambrian strata seems unjustifiable though one may certainly concede that the physical conditions remained unchanged from the Vindhyan to Cambrian times." (*ii*) "The Lower Cambrian in Southern and Western Asia was dominantly a continental period. ..... The Middle Cambrian was a period of widespread marine transgression and the Middle Cambrian sea extended from north-west America to western Asia, as far perhaps as the Dead Sea." (*iii*) "The close of the Ordovician or early Silurian marks a period of profound marine transgression over India, Burma, Indo-China, Yunnan as well as central and southern China. Indeed this transgression which appears to have reached its zenith in Wenlock times, affected the European continent as well as north America; and one common Silurian ocean seems to have spread round the northern hemisphere." (*iv*) "The commencement of the Devonian witnesses one of the most interesting episodes in the geology of southern Asia, namely, the sudden influx of a fauna which bears no relation to the faunas of immediately surrounding regions, but is a prototype of the far Mediterranean Lower Devonian fauna. ..... The marine transgression which took place in Middle Devonian times has few parallels in the geology of Asia. This resulted not only in the intermingling of the Asiatic fauna of different regions, but also, as emphasised by Reed, in the breaking down of barriers of Asiatic and European life provinces which gave rise to similar faunas in widely separated regions."

L. R. R.

11

AGRICULTURE

President: Mr. K. Ramiah

PLANT BREEDING AND GENETICAL WORK IN INDIA

PLANT breeding has formed an important part of the work of agricultural departments in India from the very beginning. The improvement in the plant types aimed at has been in the direction of enhanced yield per acre, rather than in respect of quality, inasmuch as the money return to the grower depends under present conditions upon a bigger yield than on better quality, even though the need for improved quality in a crop like cotton, for instance, is very great. The lack of exact knowledge as to what constitutes quality, the difference between the consumer's estimates of quality and those based upon scientific standards of nutrition, and the fact that a superiority in quality is sometimes offset by a lower yield and a lesser money return have retarded progress in the direction of improvement in quality. The practical results of plant breeding work in the country are very striking although the work has been in progress for a period of hardly thirty years. Taking the four important crops, rice, wheat, sugarcane and cotton, the area under the improved strains evolved by the departments covered in 1937–38 5·2, 19·5, 74·3 and 22·2 per cent. respectively of the total area under these crops. Were it not that in India there are peculiar difficulties in carrying out and financing a large-scale distribution of the seeds of improved types, these varieties would have extended over a much larger area and the work of the plant breeder benefited more growers. The extent of increase in yield is never less than 10 per cent., but is generally a good deal more and even markedly so as in the case of sugarcane. A mere comparison of the average yields of crops in the published statistics for the whole of India, with similar figures of other countries, does not give a true picture of the results achieved by breeders. Compared with the total crop areas in a country as large as India with its wide climatic variations and other conditions, the areas under improved varieties are small, and the increased yields thereon are not only masked, but the potentialities of the variety are reduced materially by lack of adequate manuring, irrigation and the like. The cotton Co. 2 and certain rice strains in Madras have demonstrated possibilities under favourable conditions, and it may be claimed that both in respect of standards of work and of the results achieved plant breeding work in India is quite comparable with the work done in more advanced countries. In this connection attention is drawn to the admittedly unsatisfactory figures of the Indian crop statistics, and recent attempts to rectify matters are referred to.

In India as elsewhere plant improvement has been sought to be effected by the three familiar methods of introduction, selection and hybridisation. The first is very limited in scope, in

view of the variety of local conditions of environment which have already brought about the most suitable adaptations. In respect of selection among the self-fertilised crops, wheat, jowar, rice and other cereals, the aim has practically been an isolation of pure lines and subsequent testing to find out the best among them. The picking out of the primary selections in the mixture of types which is mostly the case has to be largely left to individual skill and the practised eye, and success depends on the large number of selections handled in the test. The practical difficulty of testing accurately, the very large number of types involved is now materially reduced by recent advances in statistical methods, notably, the incomplete randomised blocks method and modifications thereof; thanks also to the statistician, it is possible even to carry on simultaneously with the tests on the breeders' plots, tests in the cultivators' fields, and thereby to secure a speeding up of the process. Secondary or further selection after this stage, taking only the yield character, the scope for improvement is little, and in any case there are no records of systematic secondary selection in the cereals. Even in the case of cotton, as far as yield is concerned, secondary selection is of small importance, and the secondary selection, which nevertheless is generally practised, has been in respect of ginning percentage and length of fibre in which heterozygosity persists even after severel generations of selfing. Genetic variability, which is the starting point for selection, is often masked by the effect of environmental variation, but a method has been evolved to study them freed from such interaction. By this method improvement in cotton has been effected in Indore in characters for which the type was considered to have been fixed; it has furthermore been applied to the evolving of wilt resistant types, whereby from material showing 60 per cent. wilt mortality types showing less than 10 per cent. mortality have been selected. Even in cereals the method showed that, though there was no progressive improvement in yield by secondary selection, genetic variability could still be demonstrated, such as, the lodging of straw.

In regard to the third method of plant breeding, *viz.*, hybridisation, the production of genetic variation by crossing gained the scientific foundation necessitated by the rediscovery of Mendel's laws, which also gave rise to great hopes that many valuable attributes coming from different parents could be combined in a single new plant. These hopes have not been realised, if we take increased yield as a criterion of plant improvement. Greater success has, however, been attained in other directions like disease resistance; Prof. Biffen's, rust resistant wheats and Prof. Nilsson-Ehle's winter resistant wheats and barleys, in Europe and the wilt resistant *arhar* of Pusa, wilt resistant cotton of Bombay and the blast resistant rice of Madras are notable examples.

On the subject of mixture *versus* pure types the address is reminescent of the heated controversy on this subject of thirty years ago, and the views expressed are not only different from orthodox ideas, but have important bearing on the course of future practical work. Experimental evidence is brought forward to show that mixtures have given a higher yield than their components, and it is explained that the undoubted superiority of pure types over mixtures in the case of rice, cotton, jowar, etc., applies only within a limited range of conditions existing in the tracts where they were evolved, and that mixtures would prove more useful over a wider range of conditions. It is also stated that some crops like the Upland cotton of Central India do better in competition with others than when grown pure. The former suffers less from leaf roll and red leaf when grown in association than when grown pure. The resulting mixed cotton has also been found to possess a higher spinning value than the average of the two constituents, giving thus a higher money value to the mixed cotton. Notwithstanding well-established ideas to the contrary on this all-important matter these opinions of such a great authority merit serious consideration.

The address then traces the progress of genetical science through its several phases, the study of the chromosomes as the carriers of the hereditary units, the genes, research in cytology, attempts at wide interspecific crosses, the use of X-rays, colchicine and other agents for the alteration of chromosome numbers and the production of mutations quickly and more abundantly—all of which have helped to afford to the plant breeder greater control over his material, although as far as practical results are concerned much has not followed this progress in the new science. A notable exception, however, is provided by the work on maize in America. In India genetics comprised largely a study of the inheritance of simple characters which were all found to obey simple Mendelian ratios. Yield, ginning percentage, staple length and similar characters which, as the resultant of several single unit characters, are controlled by numerous genes have not received much attention on account of the great difficulties in following their complex inheritance. The actual contribution has been by way of selections, many of which however were found of limited adaptation necessitating the opening of breeding stations on an extended scale for evolving strains suited to different environmental conditions. In hybridisation a knowledge of the inheritance of the characters which are sought to be combined was lacking in India and advance was due to a hit or miss method and success was the result of accident. The estimation of genetical variance as an aid to selection is then illustrated by some recent work on certain cotton crosses by a highly complicate statistical technique. The extent to which heterosis can be profitably made use of in breeding is next discussed and *bajra* is suggested as a suitable crop for the utilisation of this method, which in the U.S.A. has produced the famous hybrid corn of that country. The question of correlations is then taken up, and the poor chances of combining characters where the correlation is physiological is stressed by the examples of failures of work in combining high yield with short duration in rice in Madras. There is a greater chance in respect of genetically

correlated characters though even here there are limits to such combination. The use of the 'discriminant function', by which the component factor which shows the least variation due to environment is determined and utilised, is referred to in the case of the components of the yield character in rice and cotton. Dealing with the subject of wide crosses, the advantage in respect of hardiness and resistance to diseases secured by crossing with wild types is pointed out, which has also been availed of an Indian work. Some outstanding work on wide crosses are already to India's credit, and the bamboo sugarcane cross and the sorghum sugarcane cross of Venkataraman, and crosses effected between Asiatic and American cottons are all referred to. It is, however, pointed out that there is a limit to the amount of combination of characters expected in wide crosses owing to the tendencies of certain parental species characters to stay together, these being borne but by the failure of certain rice crosses in Madras and the U.P. to come up to expectations.

The address next deals with the need for maintaining strains pure and combating the tendency to deteriorate, keeping up a nucleus in the breeding stations and again for the carrying out of basic research in genetics. Though a certain amount of such research has been in progress at various centres in India it is claimed that with greater co-ordination more valuable results can be expected, as has been achieved in the study of the chromosomes of maize in America. A plea is also put in for the formation of a Bureau of Plant Introduction for India on the American model and for the introduction of genetics as a subject of study in the Veterinary Colleges of India. The address concludes by emphasising the desirability of a change of outlook in the botanical teaching of our Universities, firstly by the introduction of genetical studies of agricultural crops in the syllabus and secondly by establishing greater contact between the Universities and the agricultural departments, such contact having already proved fruitful, as exemplified in the case of the work on the rusts of wheat and that on statistical methods applied to agriculture.

A. K. Y.

THE MAGNETIC ACTIVITY OF THE YEARS 1939 AND 1940

BY

M. R. RANGASWAMI

(Colaba Observatory, Bombay)

THE magnetic activity for the years 1939 and 1940 was larger than that for the year 1938, as seen from the magnetograms of the Alibag Magnetic Observatory. The method adopted by the Bombay Observatory for determining the magnetic characters of individual days is that recommended by the International Commission of Terr. Mag. and Atm. Elec.[1] The mode of classification of days into *quiet* and *disturbed* days has been described in an earlier note.[2]

During the year 1939 there were 95 quiet days, 229 days of slight disturbance, 32 of moderate disturbance and 9 of great disturbance. In 1940, there were 101 quiet days, 222 days of slight disturbance, 36 of moderate disturbance, 5 of great disturbance and 2 of very great disturbance. During 1939, according to both Bombay and International classifications, April was the most disturbed month and November the least disturbed one. For 1940 International Character figures are not available but according to Bombay classification only, April was the quietest month. March can be considered to be the most disturbed month although the monthly mean character for March was slightly lower than that for January. The mean monthly characters for the year 1939 according to Bombay and International[3] classifications based on data from 62 observatories are given in Table I.

TABLE I
(Magnetic Characters, 1939)

Month	Classifications	
	Bombay	International
January	0·71	0·51
February	0·89	0·86
March	0·97	0·96
April	1·03	1·01
May	0·94	0·93
June	0·83	0·78
July	0·97	0·83
August	0·77	0·66
September	0·70	0·66
October	0·97	0·87
November	0·70	0·47
December	0·77	0·63
Year	0·854	0·763

[1] *Vide* their Circular letter of March 1924.

[2] *Current Science*, 1940, **9**, 90.

[3] Van Dijk, G., *Terr. Mag.*, 1940, **45**, 351.

The monthly mean characters for 1940 according to Bombay classifications only have been given in Table II.

TABLE II

(*Magnetic Characters*, 1940)

Month	Bombay Classification
January ..	1·06
February ..	0·72
March ..	1·03
April ..	0·76
May ..	0·77
June ..	0·77
July ..	0·71
August ..	0·87
September ..	0·77
October ..	0·74
November ..	1·03
December ..	0·90
Year ..	0·839

The Bombay Characters for the years 1939 and 1940 are nearly equal being 0·854 and 0·839 respectively. The number of days of different Characters in individual months during the years 1939 and 1940 have been given in Table III.

During the year 1939, there were 17 magnetic storms of moderate intensity and 7 of Great intensity. In 1940 there were in all 18 storms of which 14 were of moderate intensity and 3 of great intensity and 1 of very great intensity. The storm of very great intensity began at 13*h*. 50*m*. G.M.T. on Easter Sunday, March 24, 1940, and ended at about 18·5 hours the next day. This, the most violent storm recorded by the Bombay Observatory during the last 70 years, caused considerable havoc to telegraph, radio, telephonic and telephotographic communications. Besides, it caused disturbances to electric power systems. Similar disturbance had never been observed in the case of any severe magnetic storm in the past. During the intensest period of this storm the traces at some of the magnetic observatories of the world went off the photographic chart; this has resulted in a large number of these observatories equipping themselves with wide-range magnetographs. According to McNish, this storm probably stands pre-eminent in the annals of terrestrial magnetism.[4] For a detailed description of this storm as recorded by the instruments at the Alibag

[4] McNish, *Terr. Mag.*, 1940, **45**, 360.

TABLE III

Year	Month	Bombay Classification 0	1	2
1939	January .	9	22	..
	February .	8	16	4
	March .	4	24	3
	April .	4	21	5
	May .	5	23	3
	June .	6	23	1
	July .	9	14	8
	August .	11	16	4
	September .	11	17	2
	October ..	8	16	7
	November .	10	19	1
	December .	10	18	3
	Total ..	95	229	41
1940	January ..	4	21	6
	February .	9	19	1
	March .	9	12	10
	April .	13	13	4
	May ..	9	20	2
	June ..	9	19	2
	July ..	10	20	1
	August .	6	23	2
	September ..	9	19	2
	October .	10	19	2
	November .	7	15	8
	December ..	6	22	3
	Total .	101	222	43

Magnetic Observatory, reference is invited to an earlier note[5] in this Journal.

Among the storms of Great intensity, the one of February 24, 1939 was associated with the display of Aurora Borealis in Great Britain. The times of commencement and cessation of the storms of Great and Very Great intensity together with the ranges of different elements during the storms are given in Table IV.

[5] *Current Science*, 1940, **9**, 167.

TABLE IV

Date	G. M. T. of Beginning		G. M. T. of End		Ranges D	Ranges H	Ranges Z	Intensity G = Great V. G. = Very Great
	H.	M.	D.	H.	/	r	r	
1939, Feb. 24	02	42	25	22	8·5	>335	37	G.
Apr. 17	01	57	18	00	8·2	345	83	G.
,, 24	17	37	25	23·5	8·0	370	43	G.
June 13	16	47	14	18·5	7·3	217	71	G.
Aug. 12	01	42	14	15	9·0	261	73	G.
,, 22	00	42	23	19·5	10·2	315	58	G.
Oct. 13	02	03	14	00	10·0	294	62	G.
1940, Mar. 24	13	50	25	18·5	17·1	>785	>100	V.G.
, 29	16	02	31	02·5	7·9	266	74	G.
Mar. 31	09	42	Apr. 02	22·5	5·9	242	41	G.
June 25	02	54	26	07	13·9	340	96	G.

IDENTIFICATION OF COMMERCIAL TIMBERS

THERE are now more than 500 Indian timbers that are known to commerce. Of these only a few can be recognised by their look. Carpenters, timber contractors and others who handle timbers are often quite good at recognising them by their superficial colour and grain, but experience has shown that colour is a variable factor and that superficial grain depends considerably on the method of conversion. The most accurate way of identifying a timber is by its anatomical structure that can be seen in the cross-section. The colour of teak timber may vary, depending on the locality in which the tree grows and its superficial grain may be different in differently converted timbers, but its anatomical structure in the cross-section will seldom vary. This fact is well utilized by the Wood Anatomists or Wood Technologists, who make a thorough study of various timbers and collect data on their anatomy. Their method of study is often slow and laborious and the data collected by them may have to pass the critical eyes of the statistician and yet some practical results are achieved. Samples of timber are daily received by the Wood Technology Department of the Forest Research Institute from people who want to know whether they have obtained the correct timbers for certain specific uses. It is becoming more and more evident that a great number of people now realise that the use of a wrong timber often results in considerable financial loss. Help of this kind is being continuously given by the Wood Technology Section of the Forest Research Institute to the various Provincial Governments, the Railways, the Defence Department, the Supply Department, the Royal Air Force, the Civil Aviation, the Public Works and Industries Departments, and to Corporations, business concerns and private individuals. Every year some 400 to 2,000 samples of wood are received for examination and report.

K. AHMAD CHOWDHURY.

Forest Research Institute,
Dehra Dun.

CENTENARIES

Green, George (1793–1841)

GEORGE GREEN, a British mathematician, was born at Sneinton, near Nottingham, July 14, 1793. His father was a miller. He was an almost entirely self-taught mathematical genius. In fact his first and most influential paper, *viz.*, *An essay on the application of mathematical analysis to the theory of electricity and magnetism* was published in 1828 long before he entered college. He joined the University very late—in 1833—after having been in his father's business for some years. His advanced age and inability to submit to the course of systematic training needed for the highest places in the Tripos acted as a handicap and he came out only as the fourth wrangler. Here is a contemporary remark on this: "Green and Sylvester were the first men of the year (1837), but Green's want of familiarity with ordinary boys' mathematics prevented him from coming to the top in a time race. It was a surprise to every one to find Griffin and Brumell had beaten him." In 1839 Green was elected to a fellowship of his college, *viz.*, Gonville and Caius College.

Green published nine papers including the one already mentioned, which was the first. This first paper, which is the most outstanding contribution of this genius, was published by private subscription at Nottingham. Only 100 copies were printed and it escaped the notice even of the English mathematicians till 1850–54 when Lord Kelvin reprinted it in three instalments in volumes 39, 44 and 47 of *Crelle's journal*. It was this paper that first introduced the term "Potential Function". Green wrote "The function V representing the sum of all the electric particles in the system divided by their respective distances from p ... will recur very frequently in what follows; we have ventured to call it the potential function belonging to the system."

The function generally denoted by G and constructed so as to satisfy Green's problem was given the name "Green's function" by James Clark Maxwell in about 1873. G is the potential due to the induced distribution on the bounding surface.

A most illuminating evaluation of Green's contributions to hydrodynamics and optics was given by Stokes in his reports to the British Association in 1846 and 1862 respectively.

Green read his last paper on 20 May, 1839. This finished the record of one who "as a mathematician stood head and shoulders above all his companions in and outside the University".

Green died at his native place 31 March, 1841.

S. R. RANGANATHAN
University Library,
Madras.

SCIENCE NOTES & NEWS

An Improved Burette.—Mr. S. L. Phansalkar, Factory Manager, B.M.S.S., Ltd., Borgaon, writes: In volumetric analysis the accuracy of the results depends upon the knowledge of the exact amount of the liquid delivered from the burette. In ordinary practice the burettes that are used have graduations on them such that 1 c.c. is divided into 10 parts, the reading being taken correct to the first place of decimals, the second figure being a personal factor of the observer.

In the micro-burettes, where the cubic centimetre is divided into 20 parts with markings for each division, with enough space separating each of them, the reading could be taken correctly to the third place of decimals; but the diameter of the tube in the micro-burette is so small that the convenient size of the burette has a limited capacity, usually of only 5 or 10 c.c. A micro-burette of substantially greater capacity would be unwieldy to operate and inconvenient in size.

In the titrations or other volumetric measurements in practice, where large volumes of liquids are to be measured, a micro-burette if used necessitates the frequent refilling of the burette with consequent trouble or if an ordinary burette is used the accuracy of the measurement has got to be sacrificed.

The burette described here retains the large capacity of an ordinary burette while it gives the accuracy that could be obtained with a micro-burette.

The improved burette consists of two suitably graduated tubes, one of which is of substantially smaller diameter (micro-burette) than the other (ordinary burette) the tubes being provided with an outlet common to both and a stop-cock by means of which the liquid can be discharged from the tube of large diameter to the outlet or to the tube of small diameter or the liquid from the tube of small diameter independently discharged through the outlet as desired.

According to the particular burette here illustrated the standard 50 c.c. burette with divisions for 1/10 c.c. is provided with a micro-burette of 0·5 c.c. capacity with 20 divisions on it, fused on to it on the stop-cock, the 20th division on the micro-burette being a little lower than the 50 c.c. mark on the burette. The stop-cock has got a "Y" hole bored through it, which allows connexion to be made between the burette and the micro-burette or the burette and the delivery tube or the micro-burette and the delivery tube when suitably turned.

The burette is used in the following manner:

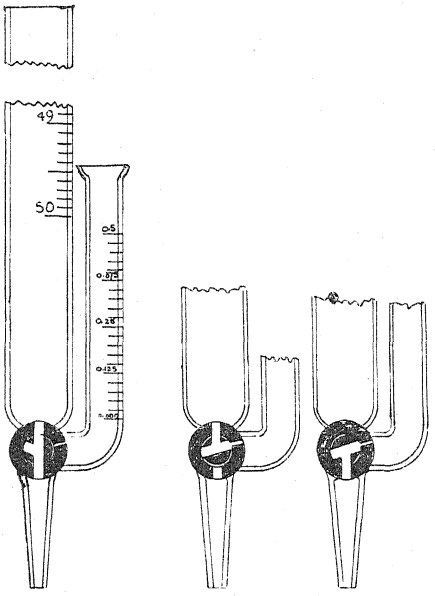


FIG. 1

After rinsing the burette and micro-burette with the liquid the burette is nearly filled to the zero mark, the air bubbles allowed time to escape, and then the stop-cock slowly turned so as to open the burette to the micro-burette and the liquid allowed to flow in the latter till it reaches the zero mark on it (micro-burette), when the stop-cock is closed and the level of the liquid in the burette adjusted to the zero mark.

The titration is carried out as usual, without disturbing the level of the liquid in the micro-burette. When the titration is complete and the level of the liquid in the burette coincides with the division mark on the burette exactly, there is no need to use the micro-burette as the reading obtained is itself quite accurate, but if it does not so coincide with any mark, then the stop-cock is slowly opened to make connexion between the burette and the micro-burette and the liquid is allowed to flow in the micro-burette until the level of the liquid in the main burette coincides exactly with a division mark on it, when the stop-cock is closed.

The readings on the burette and also that on the micro-burette are then taken. After the readings are taken the stop-cock is turned and the liquid in the micro-burette allowed to drain off until the level of the liquid in it once more coincides with the zero mark, when it is again ready for the next titration.

From the reading obtained on the burette the reading on the micro-burette is subtracted to give the exact amount of the liquid delivered from the burette.

As an example of the practical use of the burette let us assume that after the titration has been carried out the level of the liquid in the burette stood a little above the 8th mark above the 42 c.c. division—which means that a little more than 41 c.c. of the liquid has been delivered from the burette. The stop-cock is now properly turned and the liquid allowed to flow into the micro-burette until the level of the liquid in the burette falls down to the 41·5 mark, then the stop-cock is closed.

The level of the liquid in the micro-burette stands, say, half way between the 14th and the 15th marks and since the volume of the liquid in the micro-burette is equal to 0·025 c.c. per division is equal to $14{\cdot}5 \times 0{\cdot}025$ or at 0·362 c.c.

Then, the total volume of the liquid delivered from the burette is equal to

$$41{\cdot}5 - 0{\cdot}362 = 41{\cdot}138 \text{ c.c.}$$

An Abnormality in a Sathgudi Orange.—Mr. R. Ratnam, Lawley Road P.O., Coimbatore writes: In a consignment of *Sathgudi* or *Chinee* orange (*Citrus sinensis*, Osbeck: Tanaka[1]) (tight jacket type) received from Chittoor District of Madras Presidency, a case of a "fruit within a fruit" was noticed. The fruit was normal to all outward appearances but on peeling off the rind and opening out the carpels, a greenish yellow miniature fruit was found imbedded in the centre. The outer covering of the miniature fruit presented a glandular appearance just as the normal fruit of a ripe orange fruit. On opening it longitudinally, a central stalk with two cells was also seen.

Worsdell[2] has reported that this abnormality is found in the naval orange. He calls this phenomenon a case of "Positive Dedoublement" wherein a completely formed second small orange is developed inside the normal one. It does not, however, appear that this kind of abnormality has been reported previously in *Sathgudi* orange.

December 31, 1940.

Ultra-High Frequency Phenomena.—Studies in ultra-high frequency phenomena are gaining prominence in recent years as these frequencies provide the only channel through which successful high definition television is possible. The October 1940 issue of the *Proc. I. R. E.* contains two important papers on the subject. The first is by Waynick on the Propagation of Ultra-Short Radio waves of 41·5 and 45 mega cycles. The transmitter was located at Alexandra Palace television station in London and the signal strengths were recorded at the Cavendish Field laboratory situated at a distance of 71·3 km. which is 0·9 km. beyond the optical limit from a spherical earth. Further, the receiving antenna was well in the shadow of the Royston Hills. The output of the receiver was applied to the deflecting plates of a calibrated cathode ray oscilloscope whose deflection was linear with respect to the radio frequency voltage at the receiver input.

The fading which occurred over this transmission path could be broadly classified into two types (*a*) a fast low amplitude fading with a periodicity roughly of the order of half a minute and (*b*) a slow large amplitude fading

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1 Tanaka, T., *J. Ind. Bot. Soc.*, 1937, **16**, 227–40.

2 Worsdell, W. C., *The Principles of Plant Teratology*, Vol. II (The Ray Society, London), 1916.

of the order of 5 minutes or more. By observing the simultaneous fading on two receivers the spacing between which could be altered, the author concludes that the fading is probably due to a change in the direction and magnitude of ray curvature, fast fading resulting from small regions affecting the curvature. Good correlation between days of high signal strength and low tropopause temperature was obtained while meteorological conditions at ground level did not seem to affect the signal strength. At the frequencies employed and for the distances involved, no reflection from the ionosphere was possible—this was verified experimentally also—and hence it is concluded that fading is probably a refractive effect resulting from the density gradient of free air.

The second paper by Hamburger and Miller relates to the useful problem of the measurement of coil reactance in the 100 mc. region. A transmission line with the receiving end open was loosely coupled to a signal generator and adjusted to resonance by means of a sliding short circuit. The unknown reactance was then placed across the open end of the line and the short circuit moved a measured distance to restore resonance. The reactance could be calculated in terms of this distance and the constants of the transmission line. When the computed value of the apparent inductance (reactance/frequency) was compared with the experimental value of the same, the authors found that at about 100 mc., the experimental value of the apparent inductance was only 50 per cent. of the calculated value for a coil wound with thick copper wire while with thinner wire the experimental value was about 80 per cent. of the calculated value. The result is of special interest to those engaged in the design of chokes for ultra-high frequencies.

R. L. N.

Chemical Structures of Proteins.—The study of the breakdown products of proteins brought about by non-hydrolytic agents such as acetic anhydride has thrown fresh light on the structure of proteins. The results obtained since 1927, when the first paper on gelatin appeared, have been summarised by Prof. A. Fodor in a recent publication from the Hebrew University (*Scripta Academica Hierosolymitana*, Scientific Report No. 2, Jerusalem, 1939, pp. 84).

Proteins may be broken down by heating them to about 140° C. in non-aqueous solvents such as glycerine, β-naphthol, or acetic anhydride. The products resulting from this type of decomposition are designated *acropeptides*. They are split by proteinases only and not by peptidases. Gelatin, casein, edestin, egg albumin and the phospho-protein from yeast have been investigated in this way. Feigenbaum (*Enzymologia*, 1939, 6, 122) studied the decomposition of fibrin by β-naphthol and isolated fractions of low molecular weight (700 to 900). Similarly, Kuk (*Enzymologia*, 1939, 6, 194) has isolated from casein, products of low molecular weights representing nearly 2/3 of the original protein. The acropeptides from casein, gelatin and edestin were readily split by crude pancreas extracts and by purified proteinase preparations therefrom. These acropeptides were also attacked by pepsin but were unaffected by yeast polyptidases.

From these experiments, Fodor and his collaborators conclude that acropeptides are closed chain complexes consisting of four, or multiples of four, amino acids. These closed peptides are regarded as the fundamental building units of protein construction. As a result of the action of proteinases the closed peptide chains are opened out and only then peptidases exert their influence. As an answer to the objection that the acropeptides may be artefacts produced during the drastic treatment of the proteins, Fodor has pointed out that open chain polypeptides on similar treatment failed to form closed chain compounds. It must be stressed that the behaviour of the acropeptides towards enzymes is very suggestive. P. R. V.

Infestation of Grain by Insects.—The recent report issued by the Department of Scientific and Industrial Research (1940, pp. 54, price 1*sh.* 3*d.*) gives the results of the survey carried on by J. W. Munro with the object of (1) investigating the occurrence of grain-feeding insects especially *Calandra granaria* and *Calandra oryzæ*, (2) ascertaining whether these weevils attacked home-grown grain in the field or in storage, (3) finding out the extent to which insects infesting grain are brought into the country on imported grain and feeding stuffs, and (4) investigating the channels by which the insects are distributed.

The survey shows that there is not only an endemic or "residential" population of grain insects persisting indoors, but a constant serious influx into the ports, with imported grain and feeding stuffs. The infestation of grain thus presents a dual problem of controlling the resident and the imported population of insects.

The grain insects can be classified under two heads, namely, primary and secondary. The primary pests are—the grain weevils, the flour beetles, "khapra" beetles, the flour or mill moth, the "cacao-moth", the spider beetles and the flour mites. The secondary pests are few and entirely dependent on the conditions created by their fore-runners.

The ports, forming the centres for distribution of grain and cereal products coming from overseas, are centres for the dissemination of insects. The transit sheds, General warehouses, Granaries, silos, mills and farms usually help in this spread of insects far into the country. The transport vehicles of various kinds are also carriers of insect population to different parts.

There is no single remedy and there will be no startling or easy remedies for the trouble and loss caused by insects. Several considerations restrict the use of insecticides. Dusts, sprays and fumigants are being investigated. It is very doubtful whether an insecticide suitable for general use to destroy grain and store insects will be available.

Jute Cultivation in Russia.—The *All-Union Institute of Plant Cultivation* has for the past 13 years been carrying on experiments in the cultivation of jute in the U.S.S.R. and has proved that the crop can be successfully grown in

the Soviet Union (Indian Central Jute Committee, *Bulletin* No. 11, February 1941). From among 150 varieties imported from India and various other tropical and sub-tropical countries and planted by the Institute in certain districts of Transcaucasia and Central Asia, the varieties *Corchorus capsularis* and *Corchorus olitorius* have been selected. These plants yield 13 to 25 per cent. of fibre, and produce a crop of seeds, which will make it possible to cultivate jute in the U.S.S.R. on an industrial scale. At present the Institute is trying to acclimatize varieties with a greater yield.

Tata Hall.—The Hall of the Bihar Commercial Museum, primarily designed to show the arts and crafts of peace, has been named "Tata Hall" in commemoration of the donation of Rs. 9,500 made by the Tata Iron and Steel Company to enable the Museum Committee to wipe off the last of its debts.

The naming ceremony of the Hall was performed by His Excellency Sir Thomas Alexander Stewart, K.C.S.I., K.C.I.E., I.C.S., Governor of Bihar, on the 19th February 1941.

Opening the Hall, His Excellency said, "The name which you have chosen is altogether appropriate; for not only does it commemorate the generosity of those who have contributed so handsomely towards the construction of this building but it is a name which stands for so much in the industrial development of Bihar. In declaring open this, 'Tata Hall', let me wish it continued success in the future".

Mr. J. J. Ghandy, General Manager of the Tata Iron and Steel Company, who was present on the occasion, said, "never in the past, was the need for commercial and industrial museums so great, as it is to-day, when a nation must industrialise or perish".

Mr. Ghandy outlined the war work of the Steel Company and concluded: "It may be said, and said with justification, that this war will be won or lost on the steel front. Permit me to assure you, that, in this grim hour of crisis, Tatas, the expanding arsenal of India, will not fail".

Apart from paintings showing the various sections of the Steel Plant at Jamshedpur, the Hall contains models of Blast Furnace, Bessemer Converters, Open Hearth, Tilting Furnace, Blooming Mill and the New Rail and Structural Mills, donated by the Tata Iron and Steel Company, and a few other exhibits.

Statistical Year-Book of the League of Nations, 1939–40.—Notwithstanding present events, the technical work of the League of Nations continues without interruption, says a recent Communique issued by the Information Section of the League of Nations. "Proof of this fact is furnished, *inter alia*, by the appearance of the *Statistical Year-Book of the League of Nations*, 1939–40. This new edition comes at an opportune moment when objective and comprehensive statistical information is more necessary than ever but—owing to the inaccessibility or absence of regular national publications —singularly difficult to come by. In spite of such difficulties the *Year-Book* is highly up to date. It contains figures covering the year 1939—in some cases also the first half of 1940 —for a large number of subjects and for all countries of the world; the most recent territorial changes and the monetary measures introduced since the outbreak of hostilities are likewise reviewed in detail.

"Population problems are nowadays of considerable topical interest; population statistics accordingly occupy an increasingly prominent place in the *Year-Book*. These statistics deal not only with the present population position of the various countries, but also with their past and prospective future demographic evolution.

"The upward movement in industrial production, which began in many countries about the middle of 1938, continued up to the outbreak of hostilities and, in some cases, notably the United States and Canada, during the whole of the second half of 1939. However discordant the statistics relating to the U.S.S.R. may sometimes be, it is clear that a very striking increase in industrial production and in several branches of agricultural production has occurred in that country in recent years.

"The development of industrial technique, often encouraged by a policy of autarchy, has led to a growing use of substitutes. The German production of synthetic rubber in 1939 was estimated at 20,000 to 25,000 tons, world production of natural rubber amounting to 1,020,000 tons. Benzol, alcohol and synthetic motor spirit have in certain cases replaced petroleum spirit. In regard to textiles, the past ten years have witnessed a veritable revolution: while the world production of natural silk has tended to decline, the output of artificial silk (rayon) was in 1939 two and a half times greater than in 1930 and the output of staple fibres rose in the same period from 2,800 tons to 490,000 tons.

"A review of the monetary history of recent years brings out the spread and scope of the exchange control applied since the war in almost all countries of the world, the United States being a notable exception.

"In almost all countries note circulation has tended to rise; in some cases this tendency was accompanied by an increase in the reserves of central banks."

Indian Chemical Manufacturers' Association.—The second Annual Report of the Indian Chemical Manufacturers' Association, is, like the first, mainly a record of the Association's efforts to overcome the numerous difficulties against which the Chemical Industries in India have to contend. Almost all the important Indian firms manufacturing drugs and chemicals are now members of the Association and it is a matter for gratification that the Association has been able to secure recognition from the Government of India. Unfortunately, many of the grievances of the chemical manufacturers still remain unredressed, in spite of the strenuous fight which the Association is putting up, with the Provincial Governments, the Government of India, and the Railways. The correspondence between these bodies and the Association often shows the callousness and indifference with which even matters really

affecting the interests of the Chemical Industry are treated. Replies to letters addressed by the Association are often made months after they are received and frequently, the only action taken, appears to be to acknowledge the letter with thanks or a pious expression of regret that nothing can be done in the matter.

The first two annual meetings of the Association were held in Calcutta. Considering that the Association has now members from all parts of India, it will be very desirable to hold the next annual meeting at some other centre, say Bombay or Madras. This will help to maintain the all-India character of the Association.

Another suggestion, though on a comparatively minor point, may not be out of place. The authorities concerned would do well in future, to pay a little more attention to the language of the Report. It is to be regretted that there is hardly a page in the Report for 1939–40 which does not contain at least three or four glaring mistakes of grammar or idiom.

In other respects the Report is an excellent one and every chemical manufacturer would do well to read it. C. V.

Royal Asiatic Society of Bengal.—A special lecture was delivered at the Society's Rooms on Monday, the 10th March 1941, at 5-30 p.m. by Dr. F. Vreede, Hon. Director of the Netherlands Centre of Studies of the University of Paris, on "The Living Culture of Java and Bali". The lecturer pointed out that "the unity noticed between the Hindu Civilization of the Balinese, and the Islamic Civilization of the Javanese, which strikes even tourists in the daily life of these two highly artistic, religious and equally cultured peoples, is mainly due to a common ancestral, Indonesian tradition, greatly influenced however by ancient Hindu colonisation.

"This common background manifests itself to the present day in their shadowplay, theatrical dances and a vast ensemble of social habits and customs of a ritualistic, magic or animistic nature. The characteristic feature of both the Balinese and the Javanese Civilizations is nevertheless their spiritual and realistic view of life, which might prove one day a valuable contribution to a new world culture."

The Entomological Society of India.—The Third Annual General Meeting of the Entomological Society of India was held at Benares on the 3rd January 1941. The General Secretary's annual report showed that at the end of 1940 the Society's membership had reached a total of 114. Its income from members' subscriptions and other sources during 1940 was Rs. 2,333 and taking into account the previous balance to the credit of the Society and the expenses incurred during 1940, the Society had a net saving of over Rs. 2,000 at the end of the year. The main activity of the Society was the publication of the *Indian Journal of Entomology*. The Society's branches at Lyallpur, New Delhi, Pusa, Calcutta, Coimbatore and Karachi are maintained.

The following Office-bearers were elected:—
President: Dr. T. V. Ramakrishna Ayyar (Coimbatore). *Vice-Presidents*: Dr. N. C. Chatterjee (Dehra Dun), and Dr. Khan A. Rahman (Lyallpur). *General Secretary*: Dr. Taskhir Ahmad (New Delhi). *Joint Secretary and Treasurer*: Mr. H. L. Bhatia (New Delhi).

The Indian Society of Genetics and Plant Breeding was inaugurated at the recent meeting of the Indian Science Congress, Benares, 1941. The following Office-bearers were elected for the year 1941:—
President: Rao Bahadur T. S. Venkataraman. *Vice-Presidents*: Dr. W. Burns and Mr. K. Ramiah. *Secretary*: Dr. B. P. Pal. *Treasurer*: Dr. S. Ramanujam.

The Society will publish a journal in which papers on Genetics, Plant Breeding and Cytology will be published.

Indian Ecological Society.—This Society was inaugurated on 6th January 1941 at the time of the meeting of the Indian Science Congress Association held at Benares.

Its object is to cultivate and promote the study of plant and animal ecology by closer cooperation with Botanists, Zoologists, Geologists, Meteorologists, Agriculturists, Soil scientists, Chemists and Geographers.

The following were elected Office-bearers of the Society for 1941:—
President: Prof. S. P. Agharkar (Calcutta); *Vice-Presidents*: Dr. N. L. Bor (Dehra Dun), and Dr. S. L. Hora (Calcutta). *Secretary and Treasurer*: Dr. F. R. Bharucha (Bombay). *Members of the Executive Committee*: Mr. P. W. Davis (Ootacamund), Prof. P. W. Gideon (Dharwar), Dr. R. D. Misra (Bhagalpore), Dr. L. A. Ramdas (Poona), and Dr. T. S. Sabnis (Cawnpore).

All correspondence to be addressd to the Hon. Secretary, Royal Institute of Science, Bombay-I.

Indian Drugs for Export.—The following drugs are being produced in India in sufficient quantities for export, according to the Director-General, Indian Medical Service:

Alcohol, Alumen, Belladonna (*Atropa belladona*), Carbonei Dioxidum, Chirata, Digitalia (*Digitalis purposes*), Ferri Sulphas, Gum Indici, Hyoscyamus (*Hyoscyamus niger*), *Jalapa* (*Ipomœa Turpethum*), Kaolinum, Lobelia (*Lobelia Nicotianifolia*), Num Vomica B.P., Oil Vegetable hardened, Oleum Arachis, Oleum Eucalypti, Oleum Hydnocarpi, Oleum Mornhuee (substitute from shark liver oil), Oleum Ricini, Oleum Terebinthinæ, Opium and Crude Morphine Salts, Podophyli Resina (*Podophy Ilum emodi*), Rheum (*Rhubarb*) (*Rheum emodi*), Santoninum, Scilla (*Heginea Indica*), Sannæ Folium, B.P., Strychninea Hydrochloridum.

University of Mysore. *February* 1941:—
I. The Corner Stone of the new building for the Intermediate College at Shimoga was graciously laid by His Highness the Maharaja of Mysore, on the 12th February 1941.

II. A meeting of the Senate was held on the 27th February 1941. Among the propositions that were passed, mention may be made of the following: (1) The adoption of the Budget Estimates of the University for 1941–42.

(2) Detailed syllabus and revised scheme of examination in Geography for the Intermediate Examination in Arts and Science. (3) Revised detailed course of study in Psychology for the B.A. Honours Degree Examination. (4) Addition of Urdu in the list of subjects that may be offered for the Degree of Master of Arts. (5) Ordinance respecting the institution of the Master's Degree in Engineering. (6) Ordinances relating to the Institution of the Doctorate, *viz.*, D.LITT., D.Sc., D.E., and D.Sc. (Anatomy, Physiology). (7) Recommendation for the increase of the representatives of the Registered Graduates on the Senate to nine with a stipulation that at least three of them should be women. (8) Recommendation that the Senate be given the privilege of electing 5 of its members to the University Council, at least two of them being women. (9) Recommendation to the University Council for the allotment of a larger amount of scholarships to Depressed class students in the University. (10) Recommendation to the University Council to arrange for a course of lectures by specialists in Politics and Economics on pre-war and post-war economics and political problems, particularly with reference to Post-War International and National Reconstruction.

SEISMOLOGICAL NOTES

During the month of February 1941, 3 moderate and 6 slight earthquake shocks were recorded by the Colaba seismographs as against 1 moderate and 10 slight ones recorded during the same month in 1940. Details for February 1941 are given in the following table.

Date	Intensity of the shock	Time of origin I. S. T. H.	M.	Epicentral distance from Bombay (Miles)	Co-ordinates of the epicentre (tentative)	Depth of Focus (Miles)
4	Moderate	19	33	3280	Near 15° N., and 123° E., about 150 miles to the east of Manila	200
7	Slight	20	43	5400		
9	Moderate	00	16	3410	Near 0° and 120° E, to the north of Celebes Island	
9	Slight	09	46	4270		
10	Slight	00	50	5430		
16	Moderate	22	9	1530		
23	Slight	9	56	1750		
25	Slight	11	8	4000	Near 11° S. and 124° E., in Timor Sea	
27	Slight	15	15	3580		

MAGNETIC NOTES

The month of February 1941 was on the whole more active than the preceding month. There were 5 *quiet* days, 22 days of *slight* disturbance and one of moderate disturbance as against 9 quiet days, 19 of slight disturbance and one of moderate disturbance during February of last year. The day of largest disturbance during February 1941 was the 13th and that of least disturbance the 27th. The characters for individual days are given in table below.

Quiet days	Disturbed days	
	Slight	Moderate
5, 16, 19, 20, 27	1-4, 6-12, 14, 15, 17, 18, 21-26, 28.	13.

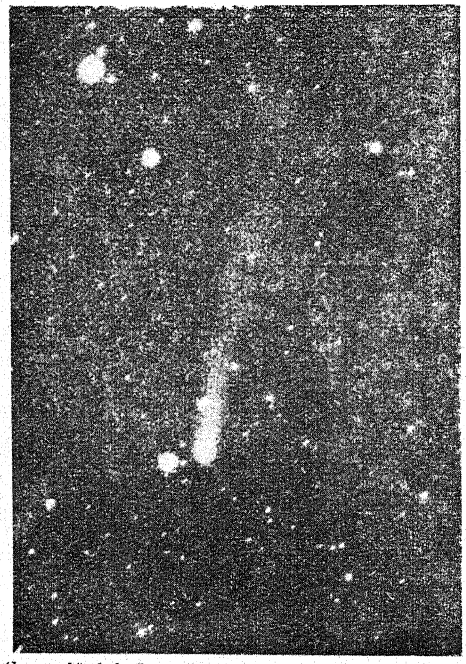
No magnetic storms occurred during the month of February this year as also last year. The mean character figure for the month of February 1941 is 0·86 as against 0·72 for February of last year.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

Planets during April 1941.—Mercury continues to be a morning star and will be visible in the eastern sky for a short while before sunrise. Venus will be in superior conjunction with the Sun on April 19 and afterwards passes into the evening sky; the planet will be close to the Sun during the month and cannot be observed. Mars is in the Constellation Capricornus and rises about an hour after midnight. It is gradually getting nearer the earth and becoming brighter, its stellar magnitude at the end of the month being $+0{\cdot}6$.

Both Jupiter and Saturn are approaching the Sun and are not in a favourable position for observation. They can still be seen as fairly bright stars low down in the western sky soon after sunset. Uranus is in Taurus and continues its slow eastward march; it will be close to Jupiter at the end of the month. Neptune will be on the meridian at about 10 p.m. and moves in a retrograde direction very near the star β Virginis (magnitude $3{\cdot}8$).



Comet 1941 I Photograph taken on February 21, 1941
Exposure $1^h\ 20^m$.
Nizamiah Observatory, Hyderabad.

Comets.—The bright comet which appeared about the end of January 1941 has considerably faded and by the end of last month became too faint to be visible to the naked eye. With a binocular or a small telescope, the object continued to present an interesting appearance and the tail although shorter than before could be traced to about a degree or so in length. The magnitude at the beginning of this month was estimated to be about $7{\cdot}0$. The apparent motion has become much slower and for a few days more, the comet can be seen in the western sky a little away to the south-west of Jupiter and Saturn.

T. P. B.

ANNOUNCEMENTS

Sir Shanti Swarup Bhatnagar has been appointed Chairman of the Indian Lac Cess Committee, *vice* Mr. Gilmore resigned.

Sir M. Visvesvaraya has been re-elected President of the Court, Indian Institute of Science, Bangalore, for the year 1941–42.

Adams Prize: Subject for 1941-42.—The Adams Prize, which is open to the competition of all persons, including women, who have at any time been admitted to a degree in the University of Cambridge, is awarded for an essay, the subject proposed for the period 1941–42 being "The theory of the elementary physical particles and their interactions". The essay may contain a discussion of the properties of some or all of the elementary physical particles and of their associated fields; the theory of cosmic rays and the structure of nuclei come under the scope of the subject. The value of the Prize is about £288, but may be increased when it seems desirable to the adjudicators, on occasions when the prize is divided. Provision is also made for the award of extra Adams Prizes in suitable cases. The essays must be sent to the Registrar of the University on or before December 31, 1942. (*Nature*, 1940, 146, 650.)

Note entitled **"A Light Effect in Chlorine under Electrical Discharge"** (this Journal, 1940, 9, 535): Prof. S. S. Joshi, in a letter addressed to us points out that paragraph 3 of the above letter beginning with "The phenomenon called A for shortness' sake" ..... and ending with "The present note, therefore, avoids their premature and undue identification" does not occur in the MSS. which he sent to us for publication. The publication of this paragraph, which occurs in the letter which gave cover to Prof. Joshi's contribution, is much regretted and may be considered as withdrawn.

We acknowledge with thanks the receipt of the following:

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4574–76.
"Journal of Agricultural Research," Vol. 61, No. 3.
"Agricultural Gazette of New South Wales," Vol. 52, Pt. 1.
"Biochemical Journal," Vol. 34, Nos. 10–11.
"Journal of the Indian Botanical Society," Vol. 20, Nos. 1–2.
"Journal of Chemical Physics," Vol. 9, No. 1.
"Experiment Station Record," Vol. 83, No. 6.
"Indian Forester," Vol. 67, No. 3.
"Transactions of the Faraday Society," Vol. 36, No. 236.
"Indian Farming," Vol. 2, No. 2.
"Genetics," Vol. 26, No. 1.
"Indian Central Jute Committee," Vol. 3, No. 11 (Bulletin).

"Journal of the Indian Institute of Science," Vol. 23A, Pts. 2–7 and Vol. 23C, Pt. 1.
"University of Illinois Bulletins," Vol. 38, Nos. 13, 14 and 19.
"Review of Applied Mycology," Vol. 19, Pt. 12.
"The Mathematics Student," Vol. 8, No. 3.
"Journal of the Indian Mathematical Society," Vol. 4, No. 4.
"Indian Medical Gazette," Vol. 76, No. 2.
"Journal of Nutrition," Vol. 21, No. 1.
"Journal of the American Museum of Natural History," Vol. 44, No. 5.
"Nature," Vol. 146, Nos. 3707–12.
"Sky," Vol. 5, No. 4.
"Science Forum," Vol. 5, No. 3.
"Science and Culture," Vol. 6, No. 9.
"The Indian Trade Journal," Vol. 140, Nos. 1808–11.
"The Grass-lands of the Argentine and Patagonia" (Bull. No. 30. Herbage Publication Series).

BOOKS

1. The Travancore Tribes and Castes, Vol. III. The Aborigines of Travancore. By L. A. Krishna Iyer (University of Travancore).
2. "Ramanujan," Twelve lectures on subjects suggested by his life and work. By G. H. Hardy. (Cambridge University Press).
3. "A Mathematician's Apology" by G. H. Hardy. (Cambridge University Press).
4. "Man on His Nature" by Sir Charles Sherrington. (Cambridge University Press).
5. "The Chemical Composition of Foods" by R. A. McCance and E. M. Widdowson. (H.M. Stationery Office, London).
6. "A Text-Book of Zoology," Vol. II, by Parker and Haswell. (Messrs. MacMillan & Co., London).
7. "Classical and Modern Physics," A Descriptive Introduction. By Harvey E. White. (Chapman & Hall, Ltd., London).

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

February 1941. SECTION A.—S. PARAMASIVAN: *Investigations on ancient Indian metallurgy. I. A pre-historic bronze bowl. II. Ancient Indian bronze coins of the 2nd and 11th centuries A.D.* R. VAIDYANATHASWAMY: *The ideal-theory of the partially ordered set.* V. C. VORA, P. M. BARVE AND B. N. DESAI: *Importance of dialysis in the study of colloids. Part VII. Colloidal zinc ferrocyanide.* With the progress of dialysis the cataphoretic speed first increases and then decreases, while the stability and conductivity continuously decrease. K. NEELAKANTAM: *Determination of lead permanganometrically (Low's method).* Hydrochloric acid, of strength $< 0{\cdot}5$ N, can be used in order to dissolve lead oxalate precipitates for titrating the liberated oxalic acid with permanganate. G. V. L. N. MURTY: *Ferric chloride as a permanent standard in the colourimetric estimation of nitrate.* P. I. ITTYERAH AND K. C. PANDYA: *Condensation of malonanilic acid with aldehydes. Part II. With* o-, m- *and* p-*hydroxybenzaldehydes. Part III. With* o-, m- *and* p-*nitrobenzaldehydes.* R. D. DESAI AND ABDUL HAMID: *Studies in naphthalene series. Part VIII. The preparation and properties of* 2 : 4-*dipropionyl*-1-*naphthol and* 4-*acetyl*-2-*propionyl*-1-*naphthol. Part IX. Properties of* 4-*propionyl*-1-*naphthol and the preparation of* 4-*propyl*-1-*naphthol.* D. A. A. S. NARAYANA RAO: *Raman Effect in gypsum.* Six frequencies due to SO_4 ion and two bands due to water of crystallization recorded and studied by means of the effects of orientation of the crystal on the Raman Spectra.

February 1941. SECTION B.—T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Contribution to the Cytology of* Tridax procumbens *Linn.*—The diploid and haploid chromosome numbers of *Tridax procumbens* Linn., have been reported for the first time to be 36 and 18 respectively. T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the Capparidaceæ—VI. Floral structure in* Cratæva religiosa *Forst., with special reference to the Morphology of the Carpel.*—Floral ontogeny and anatomy in *Cratæva religiosa* Forst., have been investigated in some detail. C. P. ANANTAKRISHNAN AND P. R. VENKATARAMAN: *The Chemistry of Garlic* (Allium sativum *L.*)—*Part III. The Reserve Polysaccharides.*—In addition to starch, the reserve polysaccharide is made up of mannose, fructose and a non-reducing acid.

Erratum

With reference to figures illustrating Professor B. Sahni's article on "Yaudheya Coin Moulds from Sunet, near Ludhiana in the Sutlej Valley" (Vol. 10, No. 2, February 1941, pages 65-67), the correct numbering is as follows :—

1	2
3	4
5	6
10*a*	11
7	8
9	10
11*a*	12

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LETTERS TO THE EDITOR

THE CONSISTENCY OF EINSTEIN'S NEW RELATIVITY WITH THE GEODESIC POSTULATE

EINSTEIN, INFELD and HOFFMANN[1] have recently obtained a solution of the problem of n bodies from the field equations

$$G_{\mu\nu} = 0, \qquad \ldots \qquad (1)$$

no use being made either of the geodesic postulate or of the energy-momentum tensor. It is well-known that (1) stands for only six independent equations. Four conditions can therefore be chosen so that the co-ordinate system is fixed and all the ten components of the metric tensor, $g_{\mu\nu}$, are known. The procedure of these authors is to build up $g_{\mu\nu}$ to higher degrees of approximation in stages contravening the four co-ordinate conditions by introducing 4 n functions. When these functions are put equal to zero the equations (1) are satisfied and the 4 n equations so obtained reduce substantially to the required 3 n equations of motion. A full exposition of this method has been given elsewhere.[2] For two particles of masses m_1 and m_2, separated by a distance r, at η^m, ξ^m at time t the equations are of the type

$$\ddot{\eta}^m - m_2 \frac{\partial(1/r)}{\partial \eta^m} = m_2 \Big\{ \Big[\dot{\eta}^s\dot{\eta}^s + \frac{3}{2}\dot{\xi}^s\dot{\xi}^s - 4\dot{\eta}^s\dot{\xi}^s - \frac{4m_2}{r} - \frac{5m_1}{r} \Big] \frac{\partial}{\partial \eta^m}\Big(\frac{1}{r}\Big) + \Big[4\dot{\eta}^s\Big(\dot{\xi}^m - \dot{\eta}^m\Big) + 3\dot{\eta}^m\dot{\xi}^s - 4\dot{\xi}^s\dot{\xi}^m \Big] \frac{\partial}{\partial \eta^s}\Big(\frac{1}{r}\Big) + \frac{1}{2}\frac{\partial^2 r}{\partial \eta^m \partial \eta^s \partial \eta^t}\dot{\xi}^s\dot{\xi}^t \Big\} \qquad \ldots \qquad (2)$$

Here m, s, t are suffixes running over the values 1, 2, 3, and the dummy-suffix convention is valid for them. A dot denotes as usual a differentiation with regard to t. The last equation gives the motion of m_1. In it m_1 appears only in one term on the right-hand side. If we put $m_1 = 0$ in (2) we get one term less and the equations of motion of a body of negligible mass are obtained.

The motion of a body of negligible mass is derived here without the use of the geodesic

postulate; the geodesics of the field of m_1 and m_2 can also be obtained in the limiting case $m_1 = 0$. The question in which one is interested is this. Will the equations of motion for the case $m_1 = 0$ as derived from (2) be identical with the corresponding equations derived from the geodesic postulate applied to the field satisfying (1)? If one studies the procedure of Einstein and his collaborators there is nothing to indicate that the two should be identical; and in fact their work is guided by the supposition that the two results need not be identical. On carrying out the necessary calculations we obtain the surprising result that the equations of motion of Einstein's new relativity such as (2) are fully in accord with the geodesic postulate at least up to the second order of the masses. The calculations in question are lengthy and they will be published elsewhere. It looks as if the result is not accidental for the number of terms involved in the equations is large. The two methods of deriving the equations, although so different apparently, might be logically interconnected.[3]

V. V. NARLIKAR.

Department of Mathematics,
Benares Hindu University,
February 24, 1941.

[1] Einstein, Infeld and Hoffmann, *Ann. Math.*, 1938, **65**, 5, 39.
[2] Narlikar, V. V., *J. Bombay Univ.*, 1939, **51**, 8.
[3] Narlikar, V. V., and Singh, J., *Phil. Mag.*, 1937, **628**, 23.

STANDARD ERROR OF THE DIFFERENCE BETWEEN TWO ESTIMATES FOR INCOMPLETE BLOCK EXPERIMENTS

THE calculation of the standard error for comparing two treatment estimates in the case of simple experiments, like randomized blocks or Latin squares, is easy and is equal to $\sqrt{2s^2/n}$, where s^2 and n are the residual variance and the number of times each treatment is repeated in the experiment. But in designs involving incomplete blocks, the algebraic expression giving the treatment differences will have to be written down for calculating their standard error. This is a very laborious and cumbersome procedure. A simple method for calculating the standard error of the difference between two treatment estimates for any experiment is given below:

First we determine the residual error of the whole experiment by subtracting the reduction in the sum of squares for blocks and treatments from the total sum of squares. To obtain now the standard error for the difference between any two treatments, calculate the sum of squares for the difference between the two treatments, as explained in a previous paper,[1] by subtracting the reduction in the sum of squares for blocks and treatments, assuming that there is no difference between the two treatments in question, from the sum of squares for blocks and treatments which has been determined before. Let this difference be A and the residual variance be s^2. It can be now shown that the standard error for the difference between the two treatments is equal to

$$\frac{s(t_1 - t_2)}{\sqrt{A}},$$

where t_1 and t_2 are the least square estimates of the treatments.

In the case of balanced incomplete blocks experiments, it is easy to see that the standard error for the difference between any two treatments is the same. But for asymmetrical experiments, this will be different for different differences.

P. V. KRISHNA IYER.
Imperial Agricultural Research Institute,
New Delhi,
January 14, 1941.

[1] *Proc., Ind. Acad. Sci.*, **11**, 369.

"EXPECTATION" OF GROWTH OF POPULATION

IN the *Indian Journal of Economics* of June 1940, Mr. D. Sen Gupta obtains the formula

$$y - d = \frac{k}{1 + ce^{rt}} \quad .. \quad .. \quad (A)$$

where y is the population, t is the time measured from a base year and c, d, k and r are

constants for extrapolating for population figures where birth, death and migration statistics are not sufficiently reliable.

2. It will simplify the notation if instead of t we write $10t$ as the time measured in years from the last census, and the figures for the decennial censuses in reverse order as a_0, a_1, a_2, ... etc., but the extrapolation formula is only required for intercensal use and we may, therefore, suppose $0 < t < 1$.

It is easy to see that a differential equation

$$\frac{1}{y}\frac{dy}{dt} = k(A - y) \quad .. \quad .. \quad (1)$$

where k and A are constants, connecting the proportional rate of growth of population with the amount by which the population at the time falls short of a constant number leads to the solution

$$y = \frac{A}{1 + e^{-Akt-c}} \quad .. \quad .. \quad (2)$$

where c is a fresh constant, which differs from (A) only in that it involves three and not four constants. It is easy to see that if the formula (1) holds the population is always above or always below A.

The constants involved can be evaluated in terms of a_0, a_1 and a_2 and we obtain a formula very similar to that of Mr. Griffiths referred to in the same paper.

3. To obtain an estimate of the effects of faulty computations of the constants A and k we differentiate logarithmically the formula

$$\log\left(\frac{A - y}{A - a_0} \cdot \frac{a_0}{y}\right) = -Akt \quad .. \quad (3)$$

obtained by using the fact that when $t = 0$ $y = a_0$.

4. Even if the A and k of the equation (1) change with time, but their changes in a period of thirty years are comparatively small, the population obtained from (3) would be fairly reliable. A and k will be characteristic of the population studied and if the formula is found to hold, the slow secular changes in these quantities should be of great interest.

5. A formula of this nature assumed to hold for comparatively short periods avoids the recent criticism of such sociological laws as Pareto's of claiming an improbable degree of universality. In passing, we observe that Pareto's Law is given an appearance of greater plausibility if we consider it as giving the "expectation" of receiving an income large in comparison with the average income of the group.

H. E. PERIES.

The Chief Secretary's Office,
Colombo, Ceylon,
February 6, 1940.

ARC DISCHARGE IN MERCURY

THE difference of potential across the electrodes of a mercury arc lamp in vacuum varies almost linearly with current, showing that here Ohm's Law holds good. It has been shown by Henri[1] that the voltage-current characteristic curve, however, showed a slight concavity towards the current axis for large values of current, when the arc was cooled by immersing the arc lamp under water.

We have been able to get a large number of characteristics for a sealed arc, at a pressure of about 0·5 mm., some of which are reproduced below (Fig. 1). The arc is cooled by blowing a current of air with an electric fan. By varying the distance of the fan, the lamp can be cooled to different degrees.

Curve I is a straight line characteristic. Curve II shows a negative or falling part in the characteristic as obtained when the lamp is cooled with the fan running at a distance of 4 metres. The succeeding curves show the falling parts more and more prominently as the cooling is increased. The falling part of the characteristic does not seem to have been observed by previous workers for mercury arcs.

The above curves show a minima of about 23·5 volts which appears to be almost independent of the degree of cooling. For this voltage the arc fills the whole of the cathode surface, while for voltages on the falling part of the characteristic the surface is only partially filled.

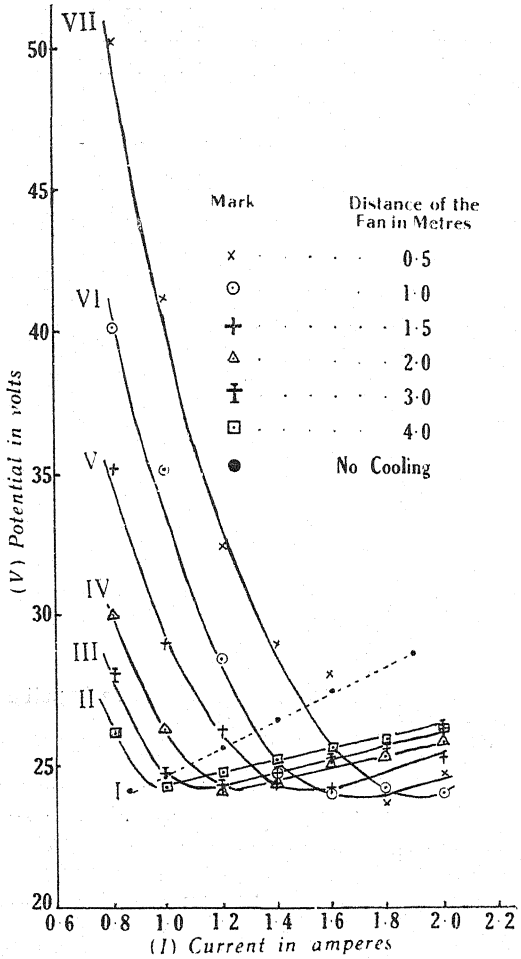

FIG. 1

Characteristic curves of a closed arc lamp at different coolings

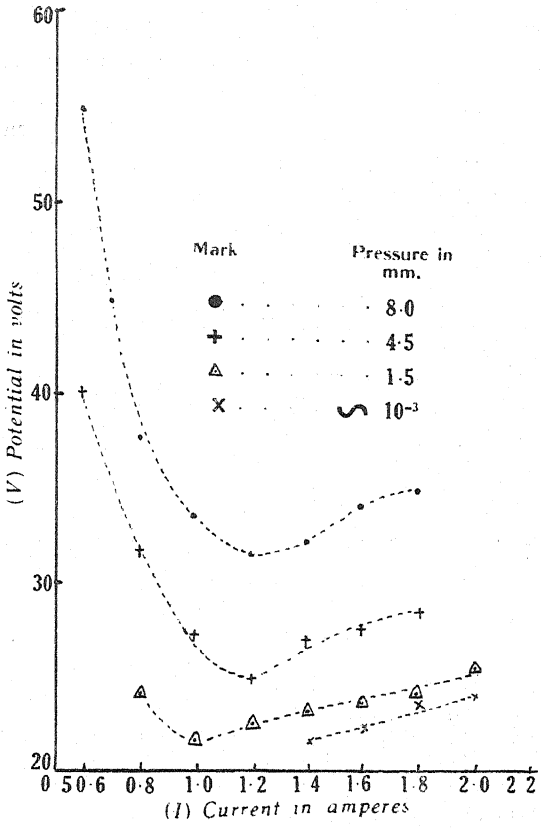

FIG. 2

Characteristic curves of an uncooled mercury arc lamp at different pressures

Fig. 2 shows the characteristics as obtained with a mercury arc lamp at different pressures, the pressure being maintained constant by admitting different amounts of air into the lamp. The lamp was not cooled. It is seen that the minimum voltage point shifts to higher values of voltage as well as current, when the pressure is increased. The falling part of the characteristic comes out prominently at higher pressures, while at pressures below roughly about 0·2 mm. the negative part has been found to be entirely absent and no amount of cooling would bring it out. This would be sufficient to explain why the mercury arc characteristic was believed to exhibit only the rising characteristic. At extremely high vacuum, even the minimum voltage point as well as a part of the rising characteristic disappear. A detailed account of this and related observations will shortly appear in *Phil. Mag.*

B. DASANNACHARYA.
C. DAKSHINAMURTI.

Department of Physics,
Benares Hindu University,
February 7, 1941.

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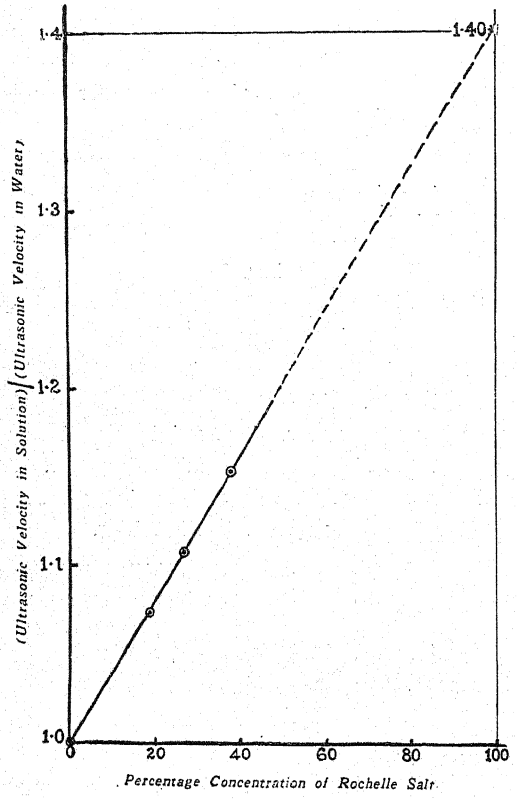
[1] Henri, *Comptes Rendus*, 1911, **153**, 426.

See also F. J. Teago and J. F. Gill, *Methuen Monographs*, page 5, 1936; and Fleming, *Mercury Arc and Rectifiers*, and Mercury vapour lamps (1925).

ACOUSTIC VELOCITY IN ROCHELLE SALT SOLUTIONS

THE physical and chemical properties of Rochelle salt [$KNaC_4H_4O_6$ $4H_2O$], which has numerous scientific and industrial applications, have been the subject of detailed study by a number of investigators. Assuming the values of the elastic constants in various directions of the Rochelle salt crystal as determined by Mandell,[1] the acoustic velocity in the crystal in any direction can be computed. For a random aggregate of minute crystals, the velocity can be estimated from the formula $V = \sqrt{\frac{K + \frac{4}{3}n}{\rho}}$ assuming for K and n the average values of the bulk and rigidity moduli and for ρ the density of the salt. The acoustic velocity computed on this basis comes out as 4,484 metres per second. From a study of the Doppler-Brillouin components in the light scattered by a single crystal of Rochelle salt one of us[2] has deduced a value of about 3,530 m./sec. for the velocity of compressional waves in the XZ plane in a direction equally inclined to those axes.



Schaaffs[3] has claimed that the ultrasonic velocity in a solid solute could be estimated by an extrapolation from the values of the velocities determined for solutions of various concentrations in any solvent. Some doubt regarding the justification for this procedure has previously been expressed. The ultrasonic velocities in solutions of naphthalene in various solvents give undoubtedly a mean value of 1554 ± 16 m./sec. for the extrapolated value of sound velocity in naphthalene.[4] It has been argued that this velocity is not characteristic of solid naphthalene and tentatively a hypothesis has been put forward that the velocity refers to a non-rigid solid state of naphthalene or to a condensed gas state. As the velocity in solid naphthalene is not known, some doubt may still linger as to the need for this hypothesis. But in the present investigation, the extrapolated value from aqueous solutions of Rochelle salt is shown to be too small compared with the velocity computed either from elastic constants or from light scattering data.

Employing the experimental procedure previously developed,[5] the ultrasonic velocities in aqueous solutions of Rochelle salt at different concentrations have been determined. Fig. 1 shows that the extrapolated value of the acoustic velocity in Rochelle salt is 1·40 times the velocity of sound in water and comes out therefore as 2092 m./sec. at 24° C. This velocity is considerably at variance with values computed from other data for a random aggregate of minute Rochelle salt crystals. Hence the view put forward by Schaaffs that the extrapolated value gives the velocity of sound in the solute is definitely shown to be incorrect. But it is undeniably a fact that this value is characteristic of the solute and can be safely used to compute beforehand the ultrasonic velocity in its solutions with any solvent, in which the sound velocity is known.

Further work is in progress and a detailed paper will appear elsewhere.

L. SIBAIYA.
R. L. NARASIMHAIYA.

Department of Physics,
Central College,
Bangalore,
February 12, 1941.

[1] Mandell, *Proc. Roy. Soc*, 1927, **116**, 623.
[2] Sibaiya, *Proc. Ind. Acad. Sci.* (A), 1938, **8**, 393.
[3] Schaaffs, *Zeits. f. Physik.*, 1937, **105**, 658.
[4] Sibaiya and Narasimhaiya, *Ind. Sci. Cong.*, 1941, and *Mys. Univ. Jour.* (under publication).
[5] Narasimhaiya and Doraiswami, *Ind. Jour. Phys.*, 1940, **14**, 187.

VISIBLE ABSORPTION BANDS OF MERCURIC CHLORIDE

WHILE investigating the absorption spectra of the halides of various elements, a characteristic band system has been observed in the visible region with mercuric chloride, which has not been previously recorded. The substance is heated in a steel tube, open at both ends, in a coke furnace to a temperature of about 1000° C. The bands extend approximately between λ 4900 to λ 4200 and consist of sequences of distinct doublet bands. Three of the sequences are well developed. They are ascribed to the diatomic molecule HgCl and are considered to form part of the class III system of bands which are reported to be poorly developed in emission by Wieland.[1] A full account of the results will be published shortly.

A. L. SUNDARA RAO.

Andhra University,
Waltair,
February 9, 1941.

[1] Wieland, *Helv. Phy. Acta.*, 1929, **2**, 46.

ULTRA-VIOLET EMISSION BANDS OF MERCURIC CHLORIDE

THE ultra-violet band spectrum of mercuric chloride as excited in a discharge tube has been photographed with a Hilger Quartz-Littrow spectrograph. The band system between λ 2900–λ 2700 reported first by Wieland[1] as due to the triatomic molecule $HgCl_2$ has been studied in detail. The assignment of this system by Cornell[2] to the diatomic molecule HgCl, and the vibrational analysis suggested by him have been confirmed. Additional groups of bands lying towards the short wavelength of each of the Q_1 sequences, have been newly classified as forming the Q_2 sequences of the same system giving an electronic doublet separation of about 90 cm.$^{-1}$ The entire system is ascribed to the transition $^2\Pi - {}^2\Sigma$. The lower state, $^2\Sigma$, is probably the same as the lower level of Wieland's class I system between λ 2650 — λ 2400. The vibrational constants, as derived from the Q_2 heads, are,

$$\omega_e' = 287{\cdot}8 \qquad x_e'\omega_e' = {\cdot}5$$
$$\omega_e'' = 281{\cdot}0 \qquad x_e''\omega_e'' = {\cdot}5$$
$$\nu_e = 36564{\cdot}2.$$

Details of the analysis will be published elsewhere.

M. G. SASTRY.

Andhra University,
Waltair,
February 9, 1941.

[1] Wieland, *Helv. Acta. Phys.*, 1929, **2**, 46, 77.
[2] Cornell, *Phy. Rev.*, 1938, **54**, 341.

INFANTILE MORTALITY AND BERIBERI

IN India beriberi as a serious public health problem is confined to the Northern Circars districts of the Madras Presidency. The disease is due to vitamin B_1 deficiency and is usually associated with the consumption of a diet consisting mainly of raw rice from which the outer layers, which contain most of the vitamin present in the grain, have been removed by machine-milling. About 70 per cent. of the rice-eating population of the Madras Presidency consumes machine-milled rice. The important difference between the dietary habits of the Northern Circars and those of the rest of the province is that in the former area raw rice is preferred to parboiled rice by the mass

of the population. Parboiled rice, in contradistinction to raw, remains rich in vitamin B_1 when highly milled, because the vitamin diffuses through the endosperm in the steaming process, and those who consume parboiled milled rice rarely suffer from beriberi. These questions are fully considered in "The Rice Problem in India"[1] in which the relation between the consumption of raw milled rice and beriberi in India was demonstrated.

In all Eastern countries apart from India in which beriberi is prevalent, the disease is known to be common among infants. It usually attacks breast-fed infants at about the third month of life, and is often fatal. Infantile beriberi has not, however, been reported in India. During visits to the Northern Circars we had the opportunity of observing clinically infantile cases which were unquestionably of this nature and this led us to suspect that infantile beriberi, though generally unrecognised, may be a serious problem in this area. Epidemiological investigations in hospitals and out-patient departments present considerable difficulties and we approached the problem by a study of the existing vital statistics relating to infantile mortality in a number of towns in the beriberi area and in other parts of the country.

The Annual Reports of the Director of Public Health, Madras, provide data about infantile mortality in municipalities in the Madras Presidency. Infantile deaths are grouped under the periods 0–1 month, 1–6 months, and 6 months to 1 year. A comparison was drawn between the proportionate mortality in these periods in 17 towns in the Northern Circars and 17 towns in the province south of Madras City in 1938, the total population concerned being approximately the same in each case. Only the records of municipalities employing health officers were investigated, because in such towns registration of births and deaths is likely to be fairly accurate. The results were as follows (Table I).

In the beriberi area infant mortality reaches its highest peak during the period 1–6 months. In the other towns and in British India generally,

TABLE I

Percentage of Total Infantile Mortality

Period	0–1 month	1–6 months	6–12 months
Towns in beriberi area (raw milled rice)	35·0	41·3	23·7
Towns outside beriberi area (parboiled milled rice)	53·0	26·6	20·4
British India (Report of the Public Health Commissioner with the Govt. of India, 1938)	46·8	30·6	22·6

the greatest proportionate mortality occurs during the first month. Further analysis showed that the reported infantile mortality in towns in the beriberi area is considerably higher than in towns outside the area, and that the excess mortality in the former is due to the larger number of deaths occurring in the group 1–6 months.

Municipal records were scrutinised to elicit the proportion of deaths at *each* month of infancy in three of the largest towns in each group, over a period of 10 years. In the towns in the beriberi area there was a striking peak in mortality at the third month, which was constantly present in all years and throughout the records of the 3 municipalities in question. It is highly probable that this peak, which was entirely absent in the records of the municipalities outside the beriberi area, is due to deaths from infantile beriberi.

The inaccuracy of vital statistics in India is well known. It may, however, be pointed out that registration of births and deaths in the Madras Presidency is more complete than anywhere else in India and that we were concerned with urban areas in which whole-time health officials were employed. Further, it is difficult to imagine how a sharp and constant peak in mortality at the age of 3 months, which revealed itself only on detailed study of the records, could be produced by errors and omissions in registration.

It is, in our opinion, very probable that a similar trend in infant mortality exists in all Eastern countries in which raw milled rice is the staple food—*i.e.*, that infantile beriberi has a specific effect on the proportionate mortality at different stages of infancy. Further investigations on this question, which is of great public health importance, are in progress.

W. R. Aykroyd.
B. G. Krishnan.

Nutrition Research Laboratories,
Indian Research Fund Association,
Coonoor,
March 5, 1941.

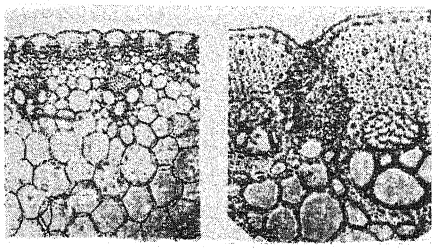
[1] Aykroyd, Krishnan, Passmore and Sundararajan, (1940), *Indian Medical Research Memoir*, No. 32.

HARD LEAF MID-RIB IN SUGARCANES AND RESISTANCE TO TOP-BORER (*SCIRPOPHAGA NIVELLA* F.)

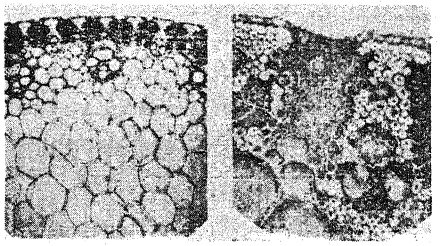
Mr. P. V. Isaac, Sugarcane Entomologist (Dipterist) at the Imperial Agricultural Research Institute, New Delhi, suggested in *Current Science* (May 1939, p. 211) hardness of leaf mid-rib in sugarcane varieties as a possible factor conducive to resistance to sugarcane top-borer (*Scirpophaga nivella* F.). This suggestion was made after an extensive examination of a number of cane varieties and seedlings in the field coupled with a study of the habits of the pest including the manner in which the larvæ enter the shoot.

Anatomical studies of various parts of the sugarcane plant—including those of various species of *Saccharum* (both wild and cultivated) and interspecific and intergeneric hybrids with *Saccharum*—have been in progress at Coimbatore, with the object of working out the inheritance of anatomical characters. The above suggestion of Mr. P. V. Isaac naturally attracted attention and structure of the leaf mid-rib was included in the studies.

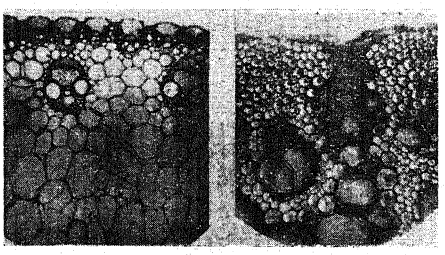
Leaf mid-rib specimens of resistant and susceptible varieties were obtained both from Coimbatore and from its substation at Karnal and sections taken at or near the hole made by the larvæ of the top-borer. The collection of the mid-rib specimens did not present any



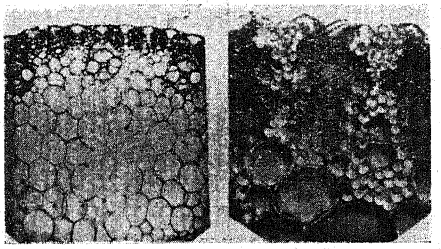
Co. 421



Co. 312



Co. 331



Co. 213

Cross-sections of leaf midrib
low power × 200 and high power × 500

difficulties. The studies have shown fair correlation between the thickening of the various mid-rib tissues and resistance of the variety to top-borer attack. The photo plate (Fig. 1) gives the mid-rib cross-sections of four canes, two of which, *viz.*, Co.'s 421 and 331 have

recorded markedly greater resistance than the other two, *viz.*, Co.'s 213 and 312.

The studies in progress have shown a definite inheritance of anatomical characters in sugarcane hybrids, and it would appear possible by a suitable choice of parents to introduce into new canes certain of the desired anatomical characters.

J. THULJARAM RAO.
T. S. VENKATRAMAN.

Imperial Sugarcane Station,
Coimbatore,
February 22, 1941.

THE CARDAMOM WEEVIL, *PRODIOCTES HAEMATICUS* CHEV. VAR IN SOUTH INDIA

IN some of the cardamom plantations in Travancore a new pest has appeared in *Prodioctes hæmaticus* Chev. var., which has been recently reported from Ceylon (Hutson, 1939) as a fairly serious pest in certain areas. The incidence of this pest in South India may have been very low till now and this may account for the absence of any record of this insect as a pest of cardamoms here.

The damage caused is during the grub stage when it tunnels into the rhizome and the basal portion of the pseudostem killing the attacked plant and gradually the associated ones also in the clump probably due to some pathogenic fungus either carried by the grub or getting access through the injured portion. The common shoot borer, *Dichocrocis punctiferalis*, is not responsible for the clump rot as only the attacked shoot is destroyed. A root boring caterpillar, (*Hilarographa* ?) is often met with but it does not bore into the rhizomes and its responsibility for the causation of the clump rot yet remains to be determined.

An account of the weevil pest in greater detail is being published elsewhere.

S. JONES.

Pampadampara Cardamom
Research Station, Trivandrum,
February 10, 1941.

[1] Hutson, J. C., *The Tropical Agriculturist*, 1939, **93**, 281.

A NOTE ON THE MINERAL WATER FROM SURANGUDI

SURANGUDI, a small village in Kulathur Zamindari in Tinnevelly District, is reputed to possess a well whose water is valued for its therapeutic qualities. At the instance of Sir P. S. Sivaswamy Iyer, K.C.S.I., who was interested in this mineral water, the geology of the area was studied. A chemical and a spectroscopic analysis of the water was also carried out.

The Zamindari lies within the coastal plain and is relatively featureless. This tract is gradually being elevated with respect to the sea, as evidenced by a shell bed 2 feet thick with recent species of *Arca* and *Cardita*, above the ground level at Surangudi. This rise must have taken place within historical times, as ancient edifices close to the coast are seen buried in sand dunes. Paving slabs of about a foot square, old pottery and coins of Raja Raja (985 A.D. to 1014 A.D.) are occasionally met with in fields.

The village stands on a hard massive dark-brown ferruginous lateritised gneiss. The rock is medium granular and shows patches of ilmenite. The soil of the area consists of red earth and black cotton clay. Sections of the rock show angular to subangular quartz grains, cemented together in a ferruginous matrix. Felspar, magnetite, ilmenite and epidote are noted.

The well is believed to be in existence from the time of King Varaguna Pandian (about 860 A.D.) and gives an yield of only 9 gallons an hour. The water is chalybeate, soft, colourless; shows a faint turbidity in transmitted light, and slight opalescence in reflected light. On exposure to air it sets free a reddish flocculent precipitate of hydrated iron-oxide.

Chemical Analysis:—Five litres of filtered water were used for the determination of total solids.

	Parts per 100,000
Total Solids	28·6
Chlorides as chlorine	0·7
(equivalent to NaCl)	1·1
Silica	16·4
$Fe_2O_3 - Al_2O_3$	1·5
Lime as CaO	0·5
Magnesium as MgO	0·06
Ba, Mn, F_2, Li, P_2O_5, and B	*nil*

Spectroscopic Analysis:—This analysis was carried out in the laboratory of The Indian Association for the Cultivation of Science, Calcutta, by Mr. P. K. Seshan under the guidance of Prof. K. S. Krishnan, F.R.S.

IRON IS TAKEN AS UNITY

0·5 to 0·1	0·1 to 0·01	0·0001 or less	Not detected
Sodium	Potassium	Manganese	Arsenic
Calcium	Magnesium	Lead	Bismuth
Aluminum	Chromium	Copper	Gold
Barium	Tin	..	Silver
Strontium	Titanium	..	Zinc
..	Rubidium	..	Cobalt
..	..	..	Nickel
..	..	..	Beryllium

There is a general belief that a continuous and liberal use of the water has produced beneficial effects in heart troubles, pains in the joints, kidney affections and menstrual complaints. A thorough clinical study may prove valuable.

T. N. MUTHUSWAMI.

Presidency College,
Triplicane, Madras,
March 7, 1941.

CHROMATIN BRIDGES IN THE ROOT TIP OF GROUNDNUT

CHROMATIN bridges were observed at anaphase and telophase of somatic mitosis in root tip cells in germinating seeds of certain varieties of groundnut. In some cells a single bridge was noticed per cell and very occasionally a fragment was also present along with the bridge. In a very few cases, two bridges were observed in a cell. Chromatin bridges are of frequent occurrence in meiosis and have also been produced artificially by means of X-rays. But very few instances are on record of the occurrence of bridges in root tip cells. Mensinkai[1] considered that the bridges he noticed in *Allium* might have been formed by the union of the ends of sister chromatids. Sikka[2] assumed that the bridges in *Brassica* originated by the breaking of the chromosomes at the point of overlap in the preceding interphase and subsequent fusion of the broken ends.

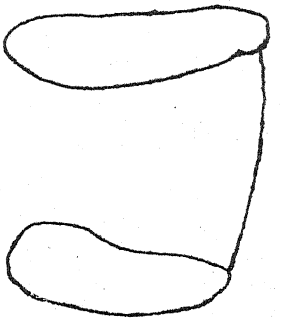


FIG. 1

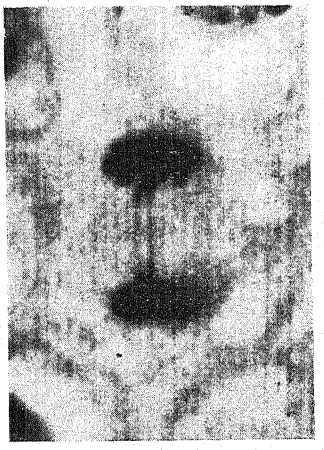


FIG. 2

Jacob[3] attributed the formation of bridges in *Clitoria* to the probable reciprocal translocation between two homologous chromosomes. Pathak[4] recorded of chromatin bridge in the root tip of *Crocus*. Nicholas[5] noticed bridges in some *Allium* varieties and concluded that 'dehydration, heat and age may cause a weakening of the chromosomes so that breaks occur at the beginning of the activity in the nucleus giving rise to aberrations which result in bridge formation'. In view of the interesting nature of the chromatin bridges and the fact that the occurrence of these in root tip cells has been recorded only in a very few cases till now, the formation of bridges in the root tips of groundnuts is herein recorded. Fig. 1 shows a bridge

and a fragment in an indigenous variety of *Arachis hypogœa* L., and Fig. 2 shows two bridges connecting the daughter nuclei in *Arachis nambyquarœ* Hoehne.

C. N. BABU.

Oil Seeds Section,
Agricultural Research Institute,
Lawley Road P.O.,
Coimbatore,
March 5, 1941.

1 Mensinkai, S. W., *Jour. Genet.*, 1939, **39**, 1.
2 Sikka, S. M., *Ibid.*, 1940, **40**, 441.
3 Jacob, K. T., *Ann. Bot*, N. S., 1940, **4**, 201.
4 Pathak, G. N., *Ibid.*, N. S., 1940, **4**, 227.
5 Nicholas, C., *Genetics*, 1941, **26**, 89.

CERTAIN ABNORMALITIES IN THE ROOT TIPS OF COTTON

IN a cytological examination of the root tips of cotton by the "Feulgen Fast Green technique"[1] the following abnormalities, not reported in this genus before, were observed.

1. Ring chromosomes were occasionally observed in *Gossypium herbaceum* L. var. *africanum* H. & G. at metaphase (Fig. 1). They

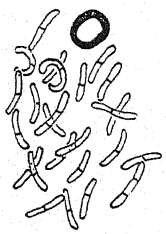


FIG. 1

Mitotic metaphase in *G. herbaceum* var. *africanum* showing a ring chromosome. × 2600.

have been previously reported in a few genera like *Crepis*,[2] *Zea*,[3] *Drosophila*[4] and *Sesbania*.[1]

2. Lateral satellites were observed in two instances. Fig. 2 shows the thread of the lateral

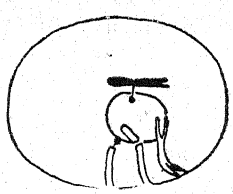


FIG. 2.

Mitotic prophase in *G. arboreum* var. *typicum* showing one chromosome with a lateral satellite attached to the nucleolus × 2600.

satellite attached to the chromosome at its constriction in prophase in *G. arboreum* L. var. *typicum* forma *indica* H. & G. Its homologue bears a terminal satellite. This appears to have been caused by the inversion of the satellited segment of the chromosome. Since the lateral satellite is attached to the nucleolus, it has to be assumed that the "nucleolar organising body" was not lost during this structural change. A similar instance has been reported only in *Sesbania grandiflora*[1] before.

Fig. 3 shows a metaphase plate in *G. herbaceum* L. var. *frutescens* Delile ("Uppam" 2919")

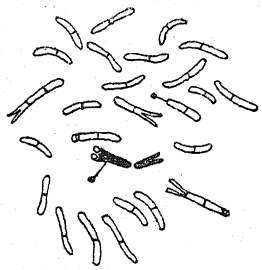


FIG. 3

Mitotic metaphase in *G. herbaceum* var. *frutescens* showing one chromosome bearing a lateral satellite.

where one chromosome bears a lateral satellite. This is longer than the normally satellited chromosome in the complement as may be seen from the figure. This necessarily means that the satellite is translocated to a longer chromosome from the normal one. Instances of chromosomes bearing lateral satellites have been reported in a few other plants like *Tradescantia*,[5] *Allium*,[6] *Crepis*,[7] *Clitoria*[8] and *Narcissus*.[9] Mather and Stone[10] in *Crocus* and Camara[11] in *Alœ* and *Vicia* also observed lateral satellites in materials treated with X-rays.

3. Cytomixis in root tips. Fig. 4 is a photomicrograph of a cross-section of the root tip in *G. herbaceum* var. *frutescens*. This root appears to have been ruptured at places A and B. Fig. 5 shows the contents of the nucleus of one cell passing into the other, the nucleolus alone being left behind. A number of 'normal cells' surrounding the injury (not the injured cells) exhibited this phenomenon to varying degrees.

Cytomixis in root tips have been reported

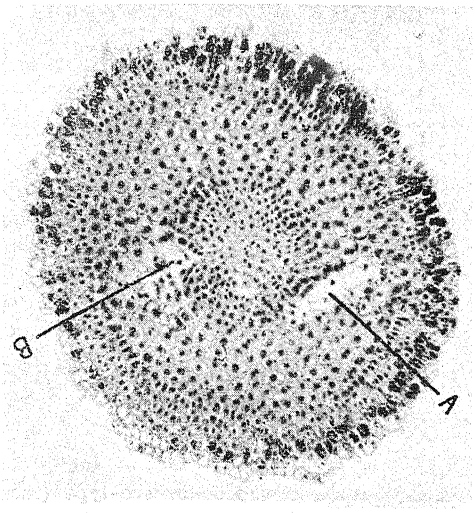


FIG. 4

Photomicrograph of the cross-section of a root tip in *G. herbaceum* var. *frutescens* showing the tissues ruptured at two places, A and B.

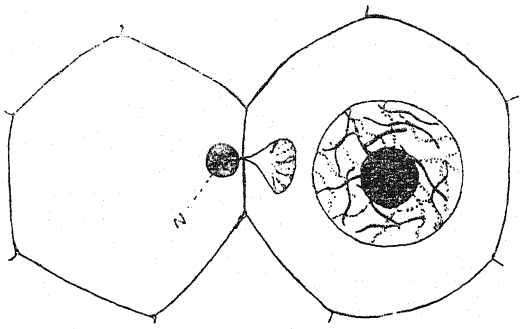


FIG. 5

Two cells enlarged to show the details of cytomixis. ×2600.

only in two instances previously (*Clitoria ternata*[5] and *Sesbania Sesban*[1]). But this phenomenon in flower buds was first reported by Gates[12] at meiotic prophase in *Œnothera gigas*, where he observed the transference of chromatin between two contiguous cells through gaps in the cell walls by means of protoplasmic connections. Subsequently a number of investigators have reported this phenomenon at meiosis from prophase of first division to telophase of second division. Katterman[13] and Jacob[1] have reviewed the relevant literature on the subject.

A few investigators hold the view that this phenomenon is brought about by the action of fixatives. But the experiences of the author and other investigators in several plant genera do not lend any support to this view. That such a phenomenon goes on in nature is unquestionable, but its causes are not quite clear. As pointed out by Gates and Rees[14] in *Lactuca*, this phenomenon is certainly an abnormal one, which may even indicate a pathological condition.

K. T. JACOB.

Cotton Breeding Station,
Coimbatore,
February 28, 1941.

[1] Jacob, K. T., *Biblio. Genet.* (in press).
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[5] Darlington, C. D., *J. Genet.*, 1929, **21**, 207.
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[12] Gates, R. R., *Ann. Bot.*, 1911, **25**, 909.
[13] Kattermann, G., *Planta*, 1933, **18**, 751.
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SOME UNUSUAL MEGASPORE TETRADS IN THE LEGUMINOSAE

IN all Leguminosæ investigated so far, the megaspore-mother cell has been observed to form mostly a linear or occasionally a T-shaped tetrad of megaspores. In a few cases, *e.g.*, *Phaseolus vulgaris*[1,2] and *Accacia baileyana*,[3] etc., only three megaspores (really a row of two megaspores and a dyad) have been reported. This results from the absence of the second meiotic division in the micropylar dyad. Of the megaspores formed, generally the chalazal one or the one adjacent to it is functional, and develops into the embryo-sac according to the *normal*-type. The rest degenerate.

While studying the embryology of the Leguminosæ, the writer has come across two unusual types of megaspore tetrads in *Cassia glauca* Lamk. var. *suffruticosa* Koenig. and *Desmodium gangeticum* DC. In the former species a linear tetrad of megaspores is the general rule and the chalazal megaspore develops into a normal 8-nucleate embryo-sac as in the Leguminosæ in general. In one case, however, where two megaspore-mother cells were seen developing side by side in the same ovule, one of the megaspore-mother cells had formed a bilateral tetrad of megaspores (Fig. 1).

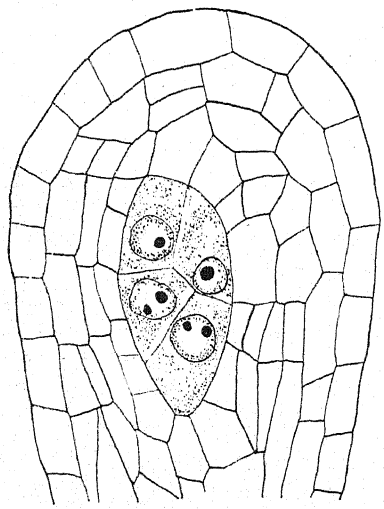

FIG. 1

Cassia glauca var. *suffruticosa* Nucellus with an isobilateral tetrad of megaspores. × 750.

This form of the tetrad is quite common among pollen grains, but is rather rare among megaspore tetrads. Coulter and Chamberlain[4] recorded one instance, namely, *Fatsia Japonica* studied by Ducamp. In a more recent review Maheshwari[5] mentions two more cases, *Myrtus communis*[6] and *Urginea indica*.[7]

In the case of *Desmodium gangeticum* also normally a megaspore-mother cell gives rise to a linear tetrad of spores and the chalazal megaspore is the functional one, but in one instance the chalazal dyad during the second meiotic division had divided longitudinally while the micropylar dyad had divided transversely as in normal tetrads. This had resulted in the formation of an 'inverted T-shaped' tetrad (Fig. 2). Until recently this type of tetrad was known

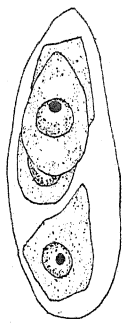

FIG. 2

Desmodium gangeticum ⊥-shaped tetrad of megaspores. × 1350.

only in the *Onagraceæ*, where the micropylar megaspore is the functional one and the resulting embryo-sac is of the *Œnothera*-type (monosporic 4-nucleate). It has been seen in *Anogra pallida* and *Zauschneria latifolia* by Johansen[8,9] (1931 *a*, *b*) and in *Ludwigia parviflora* by Maheshwari and Gupta.[10] Last year, however, Dr. Kajale[11] from this laboratory reported, for the first time, this type of tetrad in a form with the *normal*-type of embryo-sac, namely, *Cyathula tomentosa*, a member of the *Amarantaceæ*. *Desmodium gangeticum* is the second species with the *normal*-type of embryo-sac to show this kind of megaspore tetrad. In tetrads of this type the question arises as to which of the megaspores would function. In *Desmodium gangeticum* one of the two chalazal megaspores was seen to have increased in size and developed vacuoles, as shown in the figure. It is very likely that this would develop into the embryo-sac.

The writer is indebted to Dr. A. C. Joshi for help in the preparation of this note.

J. V. PANTULU.

Benares Hindu University,
February 5, 1941.

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2 Weinstein, A. J., *Amer. Jour. Bot.*, 1926, **13,** 248.
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ORIGIN OF BICOLLATERAL BUNDLES IN THE PETIOLE OF *HERACLEUM SPHONDYLIUM*

INTRAXYLLARY (internal) phloem associated with primary vascular bundles of the collateral type occur in a large number of families of Dicotyledons (De Bary,[1] Solereder,[2] Eames & MacDaniels[3]). De Bary[1] introduced the term 'bicollateral' or double collateral to designate such bundles where "two phloem groups lie on opposite sides of one xylem group" (pp. 319, 338), but the type of collateral bundles found in the Cucurbitaceæ is seen, so far as I know, in no other families where the occurrence of such bundles has been reported. As a matter of fact Herail thinks that true bicollateral bundles exist only in the Cucurbitaceæ (Sol. I, p. 394).

Investigators are not unanimous as to the way in which the internal phloem of a bicollateral bundle originates. De Bary thought that in cases where phloem abutted directly on the xylem its origin was procambial, but where an intercalary parenchyma separated them the origin was independent and was in the ground meristem.

Lamounette,[4] however, reported that internal phloem takes origin not in the procambium but in the parenchyma internal to it. Researches in the Botanical Laboratories of the Presidency College confirm Lamounette's observations so far as the Cucurbitaceæ are concerned. Esau,[5] who worked on the ontogeny and structure of the tobacco phloem, also found internal phloem differentiating from the ground meristem cells, but she observed that "when internal phloem just begins to differentiate they (the ground meristem cells) cannot be sharply delimited from the procambium" (p. 398).

Eames and MacDaniels[3] give altogether a different story of the origin of the internal phloem. They write that "branches depart from the phloem strands of roots at the level where root structure begins to change, pass inward and come to lie inside the new xylem strands, establishing bicollateral bundles" (p. 244).

All workers, however, agree that the internal phloem is always later in appearance than the external phloem of a bicollateral bundle.

In *Heracleum* the origin of bicollaterally, which may be regarded as an instance of abnormality, is effected by the fusion of two independent collateral bundles. The leaf is differentiated into a sheathing base, a petiole and a laminar region. In the base the numerous bundles are all arranged in one subepidermal level, but when they enter the petiole the lateral ones from the wings divert their courses and come to lie in two rows with their xylem almost face to face in the middle region of the petiole (Fig. 1), the central ones retaining their subepidermal position. Some of the

FIG. 1

FIGS. 1, 2, 3. T.S. of petiole. Fig. 1, camera lucida drawing showing central bundles in two rows (× 60); figs. 2. 3 photomicrographs of stages shewing the formation of a bicollateral bundle by the fusion of two collateral bundles.

lateral bundles during their course upwards come closer together, start fusing by their xylem regions (Fig. 2), their free phloem portions

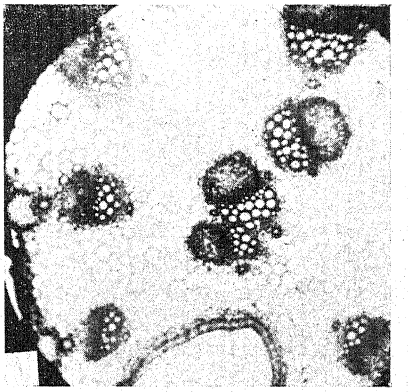

FIG. 2

orient through 90° or more degrees, and after complete fusion of the xylem strands form a typical bicollateral bundle of the Cucurbita type (Fig. 3). Joshi[6] describes and depicts a

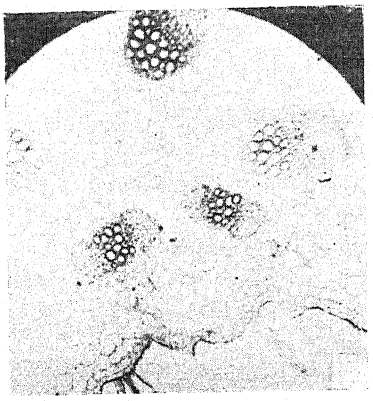

FIG. 3

similar stage in the formation of a amphixylic type of vascular bundle by the union of two collateral medullary bundles in *Achyranthes aspera* (Joshi, Fig. 6 *a*, *b*; p. 270).

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Department of Botany,
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Calcutta,
February 21, 1941.

[1] De Bary, *Comparative Anatomy*, 1884.
[2] Solereder, *Systematic Anatomy*, 1908, 2 Vols.
[3] Eames and MacDaniels, *An Introduction to Plant Anatomy*, 1925.
[4] Lamounette, R., *Ann. Sci. Nat. Bot.*, 1890, **11**, 193.
[5] Esau, K., *Hilgardia*, 1938, **11**, 343.
[6] Joshi, A. C., *J. Ind. Bot. Soc.*, 1931, **10**, 265.

TESTES IN THE ADULT COCKROACH, *PERIPLANETA AMERICANA* LINN.

THE cockroach is commonly used as a type for dissection and study in all the Indian Universities. Unfortunately the descriptions of the structure and function of testes of the common cockroach, *Periplaneta americana*, in the ordinary text-books[1,2,3] are vague and confusing. It is admitted by most authors that the testes in this species are very difficult to find and they are non-functional at its adult stage, although in *Blatta germanica* they are reported to be functional throughout life. Miall and Denny[4] state that in the adult cockroach the testes atrophy and are non-functional. To clarify the descriptions we investigated the reproductive system of the cockroach, *Periplaneta americana*. The testes (Fig. 1) are elongated

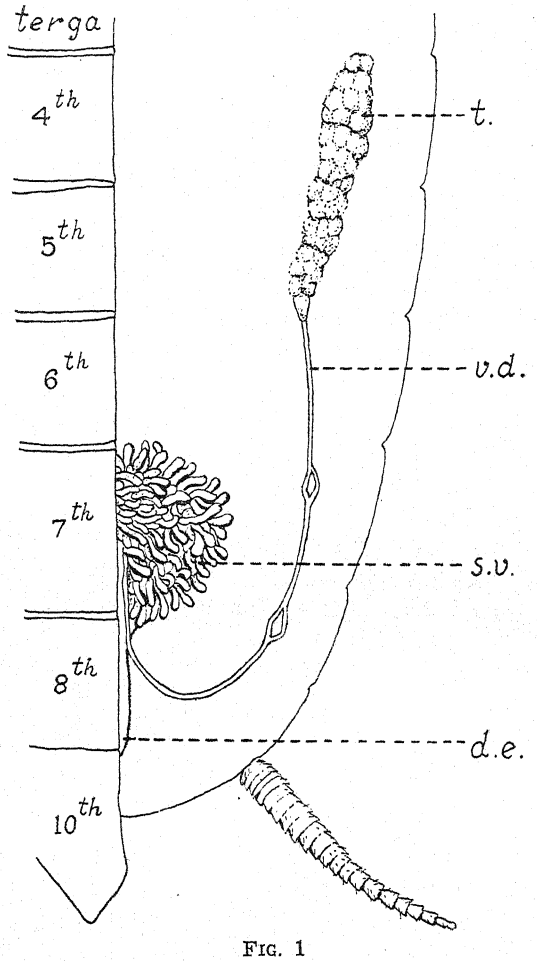

FIG. 1

Male reproductive organs of *Periplaneta americana* Terga shown on the left-hand side; *t.*–testis; *v.d.*–vas deferens; *s.v.*–musaroom-shaped gland; and *d.e.*–ductus ejaculatorius.

structures composed of small distinct globules resembling a bunch of grapes; they are conspicuous by size and are enveloped by fat. They are easily noted on the inner sides of the fourth and fifth abdominal segments. In no case we find them in the atrophied condition or shrivelled as pointed out by Miall and Denny.[4] In the adult with wings fully developed and measuring (with head deflexed) 4·4 cm. in length, the testes are 1 cm. in length and the vas deferens 1·6 cm. If a portion of one of the

testes of the adult cockroach is teased in normal salt solution (0·75 gm. in 100 c.c. of distilled water) and examined under the high power of the microscope, the spermatozoa are seen to be actively motile. Quite a number of adult male specimens of *Periplaneta americana* has been dissected and examined microscopically, in all cases active spermatozoa were found and the testes did not show any sign of atrophy, nor were smaller in size. We have also compared their minute structure with those of younger stages, and we are of opinion that the testes in the adult stage do not materially differ from those of the younger stages in which alone the previous authors[4] observed the existence of developed reproductive glands. Details will be published elsewhere.

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February 6, 1941.

[1] Balfour Browne, F., *A Text-book of Practical Entomology*, 1932.
[2] Lloyd, R. E., *An Introduction to Biology*, 1910.
[3] Wheeler, W. F., *Text-book of Zoology*, 1938.
[4] Miall and Denny, *The Cockroach*, 1886.

A STATISTICAL EXAMINATION OF TASTE DIFFERENCES IN BAJRA VARIETIES

BAJRA (*Pennisetum typhoideum*) is one of the important food crops of the population in Baroda State. Several varietal trials have therefore been conducted at the Baroda Agricultural Experimental Station for finding out the most suitable variety for the tract. Jamnagar Giant, an African variety, introduced from Jamnagar State in 1935, was one of the varieties included in these trials; but it was found that public opinion was much against it in the matter of taste, which is one of the factors against its extensive cultivation. Since taste is an important factor in any new introductions of food crops an experiment was conducted to determine the taste differences in the different varieties quantitatively. It was further thought that the result obtained would be of general scientific interest since it would show whether varietal differences in such a complex character as taste could be objectively studied by the application of the modern statistical methods.

The material for the test consisted of seven varieties of *bajra* grown at the Baroda Agricultural Experimental Station. These seven varieties were further mixed together to make a bulk and thus eight samples in all were studied. The different samples were finely ground in a common household *chakki* under as uniform conditions as possible. The flour was used in two separate trials.

In trial A, bread was prepared from the flour of the eight samples by a woman expert in this operation. Care was taken to ensure all possible uniformity in such matters as the amount of water used to make the dough, the thickness of the bread and the degree of roasting. The samples of bread were then alphabetically labelled. Eighteen members of the farm staff were invited to taste the samples and put the varieties in the order of their tastefulness. The samples were served hot, first in a random order and then as desired by each taster until he came to a definite conclusion. No consultation or any discussion between the tasters was allowed. The varieties were ranked from the least tasteful upwards so that the most tasteful variety was ranked eighth.

In trial B, the flour of the eight samples was given to two intelligent families, one that of a District Judge with five adult members, and the second, a College Professor's family with three adult members. The names of the varieties were not disclosed. In this trial it was possible to score each variety independently with a maximum of ten marks for the most tasteful sample.

The results obtained were statistically examined by the analysis of variance in the two trials.

Trial A.—The varietal totals arranged in a descending order, the standard error percentage of the mean and the significant difference between the total scores of any two varieties are given below;—

Name of the variety	Amreli	Baroda	Jamnagar Giant	Akola 136	Akola 141	Sathi	Jagudan	Bulk
Total marks	121	108	94	82	80	70	49	44

Standard error % of the mean, 9·8.
Significant difference between variety totals, 22·5.

Fisher and Yates[1] have given tables for converting such ranked data into normal scores for the purpose of statistical analysis. The data were therefore re-examined after transformation into normal scores but the resulting analysis of variance and the significance of the difference between varieties were very similar to those obtained by the analysis of the original data and confirmed the validity of the conclusions to be drawn.

The analysis of variance clearly shows that varietal differences were quite distinctly significant. The locally favoured varieties Amreli and Baroda occupy the first two places. It is remarkable that Jamnagar Giant, against which there is a considerable amount of prejudice, takes the third place and is thus classified along with the best varieties. Another interesting result is that the bulk which is a mixture of all the varieties in the trial occupies the lowest place. It is clear that due to its heterogenous composition its taste was not appreciated. The comparatively low standard error attained indicates that it is possible to perform experiments of this kind with a considerable degree of accuracy.

Trial B.—The varieties are arranged below according to their total scores:—

Name of the variety	Baroda	Jamnagar Giant	Akola 141	Akola 136	Amreli	Jagudan	Sathi	Bulk
Tota. scores	71	70	59	45	35	28	25	18

Standard error % of the mean, 13·4.
Significant difference between variety totals, 16·6.

It will be seen that except for the change in the position of the Amreli variety the results of these two indepedent trials agree with each other very closely. An explanation of the discrepancy with regard to Amreli may be found in the fact that the majority of the persons taking part in trial A belong to the farming community in Gujerat who show a general preference for the Amreli variety whereas the members of families in trial B have no reasons for such preference. There is little doubt that there is no ground for the prejudice against Jamnagar Giant as far as its taste is concerned.

The results have demonstrated that taste can be studied objectively by the application of modern statistical methods, that Jamnagar Giant variety of *bajra* was consistently classed among the best varieties and that the local prejudice against this variety was not well founded.

I am indebted to Mr. R. G. Allan, Commissioner of Agriculture, for his encouragement in undertaking this investigation, to Dr. V. G. Panse of the Institute of Plant Industry, Indore, for his help in the statistical analysis of results and to the various persons who co-operated in the investigation.

G. K. Govande.

Economic Botanist to Government,
Baroda,
February 13, 1941.

[1] Fisher, R. A., and Yates, F., *Statistical Tables for Biological, Agricultural and Medical Research*, Oliver and Boyd, London, 1938.

A QUICK AND SIMPLE PROCEDURE FOR THE ESTIMATION OF VITAMIN B_1 IN RICE

The vitamin B_1 content of Co. 9 raw husked (wooden huller) rice was determined by the biological method according to the technique of Scheunert and Schieblich.[1] The rice contained 200 I.U. or 600 γ per 100 grams. The results of the biological assay are given below:

TABLE I

Groups	Daily dose of supplement per rat: Co. 9 raw husked rice gm.	No. of rats	Sufficient	Insufficient: Decrease of wt. > 2 gms.	Insufficient: Cramps	Insufficient: Cramps and died	Insufficient: Died
a	0·5	10	10	—	—	—	—
I *b*	0·25	10	9	1	—	—	—
c	0·20	10	5	5	2	2	1
	Synthetic Vitamin B_1 I.U.						
a	0·6	10	9	1	—	—	1
II *b*	0·5	10	9	1	—	1	—
c	0·4	10	5	5	—	3	2

A sensitive Cohen's[2] type of photoelectric fluorometer which gave a deflection of 50 mm. per γ of vitamin B_1 and a blank of 10 mm. was constructed with a colour filter of methyl violet and copper chloride so that only the fluorescent energy of thiochrome was allowed to pass through and fall on the photoelectric cell.

TABLE II

No.	Strength of HCl	Kept overnight at	γ Vitamin B_1 per 100 grams of Co. 9 husked rice (observed)	Computed value γ Vitamin B_1 per 100 grams	Recovery %
1	0·1N	37° C.	267		
2	0·1N	Room Temp.	267		
3	0·5N	37° C.	298		
4	0·5N	Room Temp.	307		
5	1·0N	37° C.	304		
6	1·0N	Room Temp.	302		
7	0·5N	4 Hrs. shaking	298		
8	0·5N	2 Hrs. ,,	300		
9	0·5N	1 Hr. ,,	295	490	60
10	0·1N + Pepsin (Pyke[3])	37° C.	372	510	73
11	0·1N + Pepsin (Pyke[3]) + Taka diastase[3]	5 Hrs. at 37° C.	365	507	72

The above procedure (Table II) for the extraction of vitamin B_1 from rice were tried.

It is evident from the above results that the maximum of vitamin B_1 is extracted in the minimum time according to procedure (9). The results according to the procedures 9, 10 and 11 do not show the presence of either combined vitamin B_1 or cocarboxylase in the rice under investigation. The vitamin B_1 of the Co. 9 raw husked rice was estimated according to the method of Hills[4] (where the blank value is eliminated) and found to contain 510 γ per 100 grams of the rice which is in close agreement with the computed values according to procedures 9, 10 and 11 (Table II). A series of vitamin B_1 determinations in Co. 9 husked rice were made and the standard deviation and standard error were calculated. They were found to be 4·8 and 1·8 respectively.

In conclusion the following quick, simple and elegant method for the estimation (Thiochrome method) of vitamin B_1 in rice is recommended.

To two glass stoppered bottles 5 gm. of rice are weighed out and 50 c.c. of 0·5 N HCl are added to each. To the second bottle a known quantity of standard vitamin B_1 solution is pipetted out (to estimate the per cent. recovery of added vitamin B_1). Both the bottles are tightly stoppered and shaken for one hour on a shaking machine. Then the contents are centrifuged for 5 minutes. 3 c.c. of the centrifugate from each are used for the estimation of observed value and per cent. recovery of added vitamin B_1 respectively according to the original method of Jansen.[5] For 3 c.c. of the rice extract it is found that 1 c.c. of 1 per cent. potassium ferricyanide is the optimum quantity. Two different standard vitamin B_1 solutions are tested every time a reading is taken to determine the sensitivity of the fluorometer. The greater volume of the solutions when vitamin B_1 is added for recovery experiments is taken into account for calculations. The

vitamin B_1 content of the rice is calculated from the results of the observed value and per cent. recovery of added vitamin B_1.

The vitamin B_1 content of a few varieties of rices by the above procedure are given below:

TABLE III

Rice	Colour	γ Vitamin B_1 per 100 gms. (observed)	γ Vitamin B_1 per 100 gms. (computed)	Recovery %
Co. 9 raw husked (wooden huller)	Red	300	500	60
Adt. 11 Do.	White	302	409	74
GEB 24 Do.	,,	279	490	57
Co. 4 Do.	,,	307	404	76

The details of this paper and further work on the vitamin B_1 content of other cereals and pulses according to our procedure will be published elsewhere.

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March 12, 1941.

[1] Scheunert and Schieblich, *im Hdb. d. Lebensmittelchemie. hrsg von Bömer, Jukenack u. Tillmans Bd.* II/2, *S.* 1548.

[2] Cohen, *Rec. Trav. Chim.*, 1935, **54**, 133.

[3] Pyke, *J. Soc. Chem. Ind.* 1939, **58**, 338.

[4] Hills, G. M., *Biochem. J.*, 1939, **33**, 2, 1966.

[5] Jansen, *Rec. Trav. Chim.*, 1936, **55**, 1046.

A NOTE ON DR. KAJALE'S RECENT PAPER ON THE AMARANTHACEAE

RECENTLY Dr. L. B. Kajale[1] has published an exhaustive work on the Embryology of the *Amaranthaceæ* in which he has made some very valuable additions to our knowledge of this family. On p. 610 of his paper he mentions having found one instance in *Cyathula tomentosa* in which the four megaspores of the tetrad were arranged in the form of an inverted "T". Three other instances of a similar kind are quoted from previous literature:—*Zauschneria latifolia*,[2] *Angora pallida*[3] and *Ludwigia parviflora*.[4] Since the development of the embryo-sac in all these plants is of the *Œnothera*-type, Dr. Kajale goes on to add that in forms with a normal type of development such an arrangement of megaspores is unknown, his being the first recorded instance of the kind.

Dr. Kajale is right with regard to the rarity of this phenomenon in families other than the Onagraceæ. Its more frequent occurrence in the latter is obviously related to the fact that here the micropylar megaspore usually functions in preference to the chalazal and hence any irregularity with regard to the normal position of spindles in the homotypic division would occur in the chalazal rather than in the micropylar dyad cell. Megaspores arranged in the form of an inverted "T" are, however, not unknown in other plants. Schnarf[5] quotes Baranow (1926) as having seen such an arrangement in *Drimiopsis maculata*, Paetow[6] has observed it in *Tacca viridis* and Copeland[7] (1938) in *Styrax officinalis*. I have not particularly hunted the literature for this abnormality and would not be surprised if still other cases of a similar nature are present in earlier records.

While new reports of abnormalities and rarities are always to be welcomed, it seems necessary to warn the enthusiast from being over-confident of the priority of his own observations.

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February 17, 1941.

[1] Kajale, L. B., *Proc. Nat. Inst. Sci. India*, 1940, **6**, 597.

[2] Johansen, D. A., *Ann. N.Y. Acad. Sci.*, 1931, **33**, 1.

[3] — *Amer. J. Bot.*, 1931, **18**, 854.

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HETEROPODA VENATORIA PREYING ON A PIPISTRELLE BAT

THAT some spiders feed on vertebrates is now unquestionable. Records of account of different vertebrates, such as fish, frogs, lizards, snakes, rats, etc., being captured and fed on by different species of spiders in different parts of the world are available.[1-9] But record of any instance of spiders preying on tiny bats has not been known to me. Recently, however, I had the rare opportunity of recording an instance of the kind.

In a neighbouring village of Calcutta in a cow-shed surrounded by matted wall I witnessed a spider, *Heteropoda venatoria* Linn., preying upon a tiny bat, *Pipistrellus* Sp. Entering into the shed I noticed a pipistrelle bat struggling to drag itself out of a crevice between two bamboo strips of a wall and a big house-spider, *H. venatoria,* was seen firmly gripping the former by the neck with its powerful mandibles. There was intermittent gasping and screaming of the bat. It was dark within the shed and a torch was focussed on the spot. As soon as the light fell upon the spot, the bat screamed loudly and came out of the crevice by vigorous flapping of its wings. The spider at the same time tried its utmost to stick to the spot. The bat, however, could drag itself away a certain distance on the matted wall by crawling with its peculiar habitual gait with the help of its fore-arms, the spider all along keeping its hold. In the strife the bat was completely exhausted. After a stay in that condition for about fifteen to twenty minutes it began to flap its right wing and at the end stretched it to its utmost. Remaining in that position for a minute or two the wing slowly regained its normal position like a stretched-out limb in an atonic condition. By careful manipulation I captured the combatants and brought them home in a glass jar. They were left undisturbed for the night. Next morning the spider was found resting at the top of the jar in an upside down position and the victim was lying stiff at the bottom with the only visible injury on the neck. Evidently the bat had expired long ago and remained untouched by the spider during the night.

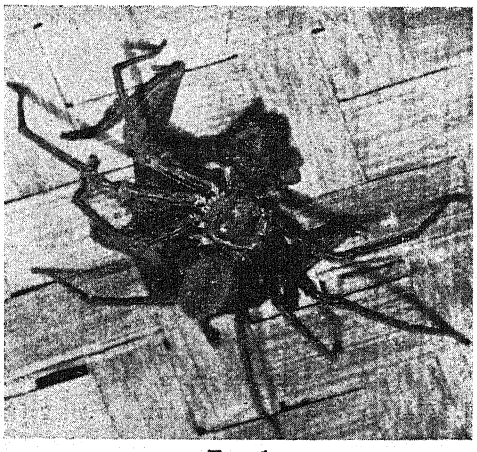

FIG. 1

The spider *H. venatoria* gripping the pipistrelle bat with its powerful mandibles.

G. C. BHATTACHARYA.

Bose Research Institute,
Calcutta,
March 3, 1941.

[1] Cambridge, *Proc. Zool. Soc.*, Lond., 1903, **1**, 152, 158.
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[7] Hutton, *Journ. Asiatic Soc. Beng.*, 1842, **11**, 860.
[8] Bhattacharya, *Sci. Monthly*, N. Y., 1934, **39**, 176.
[9] Abraham, *Ann. Natal Mus.*, 1923, **5**, 89.

SOIL SOLUTION STUDIES IN IRRIGATION PRACTICES

(With special reference to Alkaline and Saline Soils)

IN a previous paper the writer and Pollard[1] have described in detail the practical significance of soil solution studies. Methods of obtaining the soil solution and estimating various bases, fertility ingredients, and soil relations are examined and described. Value of soil solution methods has been critically examined and their application to investigation of

causes of soil productivity and exhaustion has been described.

The soil solution studies have further been extended and a detailed inquiry into the soluble salt status of alkaline and non-alkaline (healthy) soils in relation to irrigation practices has been made. Full data will soon be published.

By use of small-scale drain pipe lysimeters (*vide* plate given) permitting detachment of their contents in a number of separate layers, changes in the composition of soil solution and the movement of its mineral constituents resulting from irrigation and from the upward movement of waters are examined. The technique developed is shown to contribute extensively to the solution of problems likely to arise in connection with irrigation practices.

It is found that the addition of sodium chloride to soils results in (*a*) a depression of the solubility of phosphates, the action being

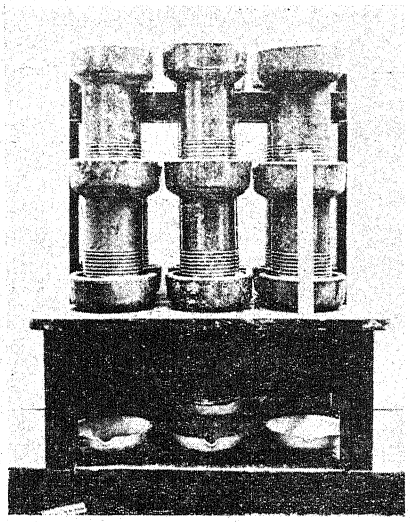

FIG. 1

reversible when sodium chloride is removed by irrigation, drainage, etc., (*b*) mobilisation of organic nitrogen constituents which thus become capable of upward and downward movement in the soil, (*c*) mobilisation of iron, aluminium, manganese, in soils of low but not in those of high lime content.

Examination of leachings, and soil solution from artificial and natural saline soils under various conditions show a general similarity of all characteristics examined. Use of artificially salted soils, therefore, appears to offer a reliable experimental basis for investigation of problems concerned notably with irrigation of saline soils.

Comparison is made of the composition of displaced soil solution and that of corresponding water extracts in which the soil-water ratio is varied. Soil extracts are shown to indicate much larger proportion of soluble calcium, potassium, carbonate, phosphate, and higher calcium-sodium ratio (on dry soil basis) than actually appear in the soil solution. The use of water extracts in assessing the proportion of soil fertility ingredients or harmful soluble salts (in case of saline soils) seems somewhat unsatisfactory.

Liberal use of irrigation water improves the salt status of almost all saline soils in surface layers, whereas such heavy doses drain off available plant food material from healthy soils. In case of salt-free healthy soils, judicious and economical use of irrigation water is recommended for maintenance of high level of soil fertility.

The new methods assist in the determination of soil nutrient values preparatory to prescribing profitable manurial treatments.

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February 25, 1941.

[1] *Indian J. Agric. Sci.*, 1939, **9**, 473.

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THE IMPROVEMENT OF INDIAN CATTLE

THERE is probably no aspect of Indian agriculture which strikes even the casual observer more prominently and at the same time more painfully than the miserable condition of the cattle of the country, unless it be the thin emaciated form of the cultivator himself toiling patiently behind his equally patient team of oxen. And yet in no country is it more necessary that its cattle should be looked after better than in India, for as H.E. the Viceroy of India has observed in words that can never be forgotten "the cow and the working bullock carry on their patient backs the whole structure of Indian agriculture". The bullock supplies all the power on the farm, the ploughing, the raising of the water for irrigation, the threshing of the corn, and all the transport whether on the farm or on the roads; notwithstanding the new methods of motor transport the bullock cart still holds the field as the most important form of locomotion in the country, and even the pack bullock has not become altogether obsolete. The cow and the buffalo between them meet the whole of the requirements of milk and milk products of this vast country, hopelessly inadequate though they are, and cattle manure still forms the most important and generally the only source of manure. The money value of the cattle power alone has been computed to be between Rs. 300 and Rs. 400 crores, the milk and milk products at about Rs. 300 crores and the manure at about Rs. 270 crores, while the total value of the live-stock of India inclusive of all the uses to which they are put is said to be of the order of Rs. 1,300 crores. The cattle population itself is immense, numbering about 200,000,000 head and forming roughly about one-third of the whole world's cattle population. Despite this prodigious number and the huge money value, India's cattle

wealth is however a neglected and ill-developed asset. The bullock power, large as it is, is poor and inefficient, and is contributed by small underfed and nondescript types of animals which lack the strength and stamina necessary for working even the small indigenous ploughs and other implements, and are out of the question for the better class of implements that can otherwise be advantageously introduced. Even in the tracts where a better class of animals is seen to predominate, insufficient feed lowers their value and the vice of indiscriminate and uncontrolled breeding is bringing in progressive deterioration in the qualities associated with the respective breeds. As is the case with the bullocks so is it with the cows of the country. The milk and milk products produced, vast as they are in quantity, are supplied by an immense number of cows and buffaloes whose low record of performance is a by-word in the country-side. Large as the quantity is, moreover, it is too insufficient for average needs, especially in a country like India, whose population is largely vegetarian and has a special need in respect of dairy products which supply the accessory food elements considered indispensable for normal health. This position has long been one of grave concern, and ameliorative measures have been, and are being, taken by the provinces and states both for arresting this process of deterioration and for bringing about positive improvements. To give an idea of what these measures are we may describe in rough outline what has been done in Mysore, as this will serve as a sample more or less of what has been attempted elsewhere also.

These measures have been along three main directions, *viz.*, (1) the supply of an adequate number of breeding bulls of approved type to all the villages and alongside of it the castration in good time of all scrub bulls in the villages, (2) increasing the fodder resources of the State, including the improvement of the village pastures, grazing facilities in the forests and the planting of trees and shrubs of fodder value, and (3) the combating of disease among cattle. In regard to the supply of breeding bulls many methods, each having its own good points are being tried. These comprise: the sale of bulls and bull calves to *bona fide* breeders at a fair upset price instead of selling them by auction; the grant of a yearly subvention to breeders keeping bulls of approved type for service; the meeting by local bodies of a moiety of the purchase price of the bulls in the case of approved breeders willing to abide by certain conditions regarding inspection, keeping of records, etc.; the sale to village panchayats of bulls and bull calves, the purchase price being generally met by the district boards and these bulls being made to roam among the village herds and not made to stand for service; these bulls are to be maintained at the cost of the village jointly and are to be changed once periodically for other bulls at Government cost, the object being to avoid inbreeding and probably lack of vigour; stationing breeding bulls in some of the veterinary hospitals and Government farms for service in the neighbourhood; the institution of itinerant bulls in which bulls are taken out on circuit to a fixed number of villages in accordance with a programme notified well ahead to the villages comprising the circuit. For ensuring an adequate supply of bulls, selected animals in the herds of Amritmahal cattle are reserved, these cattle are bred more or less under semi-wild conditions; secondly is the stock raised on the special

cattle breeding farm of the Government and thirdly are the bull calves which are reared on the ordinary farms of the department. Simultaneously with this programme the veterinary staff carries out an intensive campaign of castrating scrub bulls, which forms an important item in their work during tours. In addition to these measures of the Government are the vastly greater endeavours of the cultivators themselves in providing their villages with good bulls, naturally to be expected in a state, which has been for centuries the home of a famous and popular breed of cattle. Money prizes and medals at the numerous cattle fairs give some additional incentive in the same direction. As an all-India subject this matter of the supply of breeding bulls has gained great strength from the personal interest of H.E. the Viceroy Lord Linlithgow, who made it almost the first act of his Viceroyalty to issue an appeal to wealthy Indian gentlemen to donate breeding bulls or funds for purchasing them, to which the response was prompt and liberal. His Excellency's interest has further resulted in a series of comprehensive measures for the improvement of live-stock, organised on a permanent basis under the auspices of the Imperial Council of Agricultural Research. The outward and visible symbol of this new development is the all-India cattle show which is now being held in Delhi every year. In the years to come this show will serve both as a touchstone to the success of these measures and also as the most substantial impetus to cattle improvement. The wide advertisement given to the best Indian cattle and the consequent high prices which are bound to be obtained will certainly prove a more potent stimulus than any other specific factor. We may illustrate this by recalling that the palmiest days of the breeders in Mysore were the years when the large cattle fairs were being visited by the agents of the Dutch East Indies who regularly made large purchases of the best animals at very high prices. Though these remarks refer to draft cattle they apply equally well to the bull as a sire in the dairy herd. An instance in this connection of which we have a vivid recollection is the case of the small holders of the Island of Jersey to whom their pedigree bulls and cows form the greatest source of income. The prices which some of these fetch fairly take one's breath away and it is no wonder that though the holding consists only of some five or six acres it enables the farmer to live in a style which a similar small farmer in India cannot even dream of. The ordinary village cow in India even when she is in milk yields too little to merit attention while the dry cow is so neglected that nothing but the owner's religious scruples prevent her from going into the hands of the butcher. She is too often such a great liability that even these scruples cannot stand the strain of her upkeep or the temptation of the butcher's offer. There is nothing that can save the situation except making the milk producing business pay, and the greatest single factor in the problem is a better type of animal. No better proof can be quoted than the fact that in many cities the local breeds of cows have been all but displaced by cross-bred animals. The development of motor bus traffic on our roads has however given a chance to the local cow, which is also bound to improve as cow keeping within city limits will eventually be given up voluntarily or by municipal enactments. Every good male calf born to her makes her position stronger, for these calves are much prized animals, and as thus her paying capacity increases so does it earn

for her better feed and attention, to which she in turn responds with a better performance. All this forms a powerful argument for better bulls and better methods of breeding in the villages so that the economic value of the cow may be increased both as the mother of valuable progeny and as the producer of more milk. In respect of the choice of the sires ryots have little information to go by, except vague hearsay accounts of the performance of individual specimens. A desirable line of development will be the formation of cattle breeding societies, the maintenance of performance records and of a pedigree register, all matters which, unfortunately under present conditions are fraught with great difficulties.

In an equal, if not greater measure, does the improvement of live-stock rest upon an improvement of the fodder resources of the country. No matter how great the improvement by breeding may be, the lack of adequate feeding will neutralise its effect, for without such feeding the improved stock will come down gradually to the level of the original stock, and may even have the disadvantage of being less fitted to withstand the rough conditions. It may be said that Indian systems of agriculture do not comprise a definite share in the rotation of crops solely intended for cattle feed, as does the British system where, for instance, from one half to three-fourths is for animal feed. Such areas as may be put down for cattle feed are either in special cases as for bullocks working at *mhotes* or for providing some amount of concentrated feed like horse-gram, but even this is a kind of left-handed affair, the roughest land being put under it and the produce in any case totally insufficient even for the working bullocks. Money crops like cotton and groundnuts have greatly increased in area and have made further inroads into the fodder capacity of the older rotations. The steady extension of cultivation has meant a corresponding shrinkage of grazing areas. Forests are being conserved in the wider interests of the country, and forest grazing is strictly controlled. The straw, chaff, husks, pods and other by-products which the ryot has to husband carefully for the use of his working bullocks have to be drawn upon by his other animals also, insufficient as they are for the needs of the former. Barring therefore the bullocks that work at the *mhote* or at the plough or for the professional carter and the cows and buffaloes actually in milk all other cattle are left to shift for themselves and what this means on the open parched up countryside can easily be imagined. The taunt that the ryot makes *pooja* to the stone bull in the temple but neglects it in its living flesh and blood form or that he venerates his cow but does not hesitate to leave her starving may thus appear justified, superficially at least. For the six months of the year before the period of heavy rains village cattle lead a painful life of semi-starvation, and if the rains fail or come late they are unequal to a further strain and succumb in large numbers, if they do not meanwhile meet a speedier end at the hands of the butcher. In the cities milking animals are maintained on the minimum feed necessary, for the milkman himself is poor and has to keep both himself and his cow on the slender returns from the milk. The dry cows are indeed a problem. One shudders to think of the hundreds of these animals, which are said to be sent to the slaughter houses in Bombay after they cease to milk, however good they might have been as milkers. Apart from feelings of softness or mercy, the salvage of these animals is a matter of

economic importance in which missions of mercy and pinjrapoles of a modern type may well play an important role.

The question of providing adequate fodder resources is being studied in a comprehensive manner by the Imperial Council of Agricultural Research, thanks again to the initiative of H.E. the Viceroy. In addition, the various states and provinces have bestowed a great deal of attention on it and taken measures both of a permanent character and more especially of an emergency kind to cope with wide-spread fodder scarcity and distress which unfortunately are of too common occurrence. First among the fodder sources come the village grazing grounds and the improvement of these grounds has engaged a great deal of attention. It has been found next to impossible to devise a practical scheme for converting them into good grass areas as long as the common ownership continues. The land will have to be fenced, ploughed and put under grass and the grazing carried out under strict control in a proper rotation, all the labour being provided or paid for by the villagers. The difficulties are all but insuperable and though several schemes can be considered the joint ownership will always remain the chief, if not, the sole obstacle. If, however, village autonomy should become powerful enough to enforce co-operative action in this matter then there is considerable scope for this form of improvement; after all joint action of this kind is not new in our villages and the village topes or groves affording at once both restful shade and a moderate money return are even now a standing proof that effective joint action is possible; many other forms of co-operative effort can easily be cited. But under present conditions when individual freedom is put before the needs of the community these grounds can serve as nothing more than mere exercising space for the village cattle during the crop season; as a matter of fact they are being fast reduced to this rôle, because in response to clamour for arable land parcels of pasture lands are gradually being given over for cultivation, leaving only the minimum required by the rules. It should be possible however for Governments to take up and improve large stretches of waste land and develop them as pastures in the manner described. Unpromising as these waste lands may appear in their present state, what can be effected on them is demonstrated by the forest plantations called "maidan" plantations in Mysore. In addition to the tree growth in these plantations grass grows abundantly forming a good source of income. We have heard from a late head of the forest department that the income from grass has paid for the maintenance of these plantations. The very fencing and the protection thereby afforded have a striking effect on the grass growth. These areas form veritable oases in the midst of the parched up country-side and an increase in their number is a desirable step. Trees of fodder value can be substituted for the ordinary fuel trees and these should greatly add to their fodder value. In a cattle country of great importance it will be also well to set apart large areas of forest land in the moister sections of the country and develop them with an eye to their grazing and fodder value, so that during seasons of acute fodder distress, the best cattle—the foundation stock, as it were—of the country may be sent away to these havens and saved. The conservation of forest grass by annual cutting and storage as hay will also have to be undertaken. No doubt all this will cost money and not all of them may be

considered necessary in ordinary years, but they have to be looked upon as a measure of insurance, justified by the importance of the cattle industry and the magnitude of the loss which results when a serious fodder famine sets in. In the long run, however, the ryot will have to face the fact, that the only remedy lies in his growing crops solely intended for fodder as part of his ordinary farming; suitable adjustments will have to be made, cattle may have to be reduced in number, and replaced by better ones, leguminous fodder will have to be grown, animals will have to be penned or tethered and grazed and farm wastes more carefully conserved. Much encouragement by Government will have to be given in the channel-fed areas for the raising of fodder crops. The subject of mixed farming will have to receive more attention and methods suited to different tracts worked out and popularised.

We now come to the third leg of this tripod on which the improvement of the live-stock industry rests, *viz.*, the prevention and cure of diseases, especially the great cattle epidemics. This is a matter which needs no emphasis, but we may point out that one at least of the reasons why too many cattle are kept is the ryot's anxiety to guard against the depletion by disease. Rinderpest, the most dreaded of the epidemics, is sometimes partial to the larger and better class of cattle and the death of such animals brings a legacy of debt which it takes years for the owner to work out. By the wiping out of the products of good breeding the work itself receives a serious set-back. Fortunately we have in the new methods of serum treatment an almost infallible method of preventing rinderpest and to a lesser degree, the other diseases also, and it is now only a question of extending the treatment over the whole country. Research in animal diseases is now receiving great attention and before long suitable remedies may be forthcoming for other diseases as well, so that we may consider that this great obstacle has been overcome.

There is one other method of cattle improvement usually considered in this connection, *viz.*, the subject of cross breeding with the humpless cattle of Europe. This has been undertaken in India and very striking increases in the milk yield have been obtained. Both in the military dairy farms and in the Palace dairy farm in Mysore remarkable results have been attained and among city dairymen the cross-breds are exceedingly popular. For quick results among dairy cattle the method has no equal and, with proper safeguards against disease, is full of promise. Its field of limited application and the need for great precaution and control to prevent indiscriminate breaking of the type of the local cattle and the fact that it is still of an experimental character have lessened its importance.

It cannot be too strongly emphasised in conclusion that the greatest impetus to cattle improvement can come only by making it remunerative. Make the industry pay and the rest will follow automatically. The larger the custom and the higher the prices for our cattle, the greater the stimulus and the better will they be looked after. Nor need we fear that any large sale of cattle to foreign markets would endanger the permanent interests of the industry and that ryots will in view of immediate profits deplete their stocks.

A. K. YEGNA NARAYAN AIYER.

A BIVARIATE EXTENSION OF FISHER'S Z TEST

BY

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A NORMAL distribution in k variates x_1, x_2, ... x_k, each with expectation (population mean) zero is defined by the probability density $c \exp -\phi/2$, where c is always to be understood as a constant so chosen as to make the total probability equal to unity, and ϕ is a positive definite homogeneous quadratic form in the variates, *i.e.*:

$$(1) \qquad p = \frac{1}{\sigma\,(2\pi)^{\frac{k}{2}}} \int_R \cdots \int e^{-\frac{\phi}{2}} dx_1 \cdots dx_k;$$

$$\phi = \sigma^{ij} x_i x_j.$$

$$\sigma^{ij} = \sigma^{ji};\ \sigma^{ir}\sigma_{ij} = \delta^i{}_j;\ \sigma^2 = |\sigma_{ij}|.$$

Here, we use the tensor summation convention for repeated indices and the integral is to be taken as extended over that portion of the k-space in which the variates are to lie. The coefficients σ_{ij} are to be formed by taking the normalized co-factors of the corresponding element in $||\sigma^{ij}||$, as usual. Alternatively, we can write $\sigma^{ij} = \dfrac{\delta \log \sigma^2}{\delta \sigma_{ij}}$. The form ϕ being definite, the determinant σ^2 does not vanish, and there is no theoretical difficulty in finding either σ^{ij} or σ_{ij}, the matrix of the other coefficients being given.

Suppose now that a sample of n observations be taken from such a population, the jth sample value of the variate x_1 being x_{ij} Then it is known that the best[1] estimates of σ_{ij} are given by

$$(2) \qquad s_{ij} = \frac{1}{n-1} \sum_{r=1}^{n} (x_{ir} - \bar{x}_i)(x_{jr} - \bar{x}_j),$$

$$\text{where} \quad \bar{x}_i = \frac{1}{n} \sum_{j=1}^{n} x_{ij}$$

The best[1] estimate σ^2 is $s^2 = |s_{ij}|$ and of σ^{ij}, the corresponding normalized co-factors, s^{ij}.

It is well known that the quantities s_{ij} are the sample variances when $i = j$, and the sample correlations multiplied by the corresponding standard deviations when $i \neq j$. Again, s^2, the determinant of the sampling coefficients, has a strong claim to be considered as the generalized variance of the multivariate sample. The ratio of two such variances chosen from the same populations would be independent of a linear homogeneous transformation of the co-ordinates, and also of the population parameters. It is natural to ask whether the distribution of this ratio, or rather of its logarithm, has anything in common with Fisher's z, so that the z tables could be used without further ado. The answer is negative in general, but it is the purpose of this note to point out the fact that for a bivariate population ($k = 2$), such an extension is valid.

2. Following the methods given by Uspensky,[2] it is a comparatively simple matter to find the distribution of S, where

$$(3) \qquad S^2 = \det \cdot \left\{ \sum_{r=1}^{n} (x_{ir} - \bar{x}_i)(x_{jr} - \bar{x}_j) \right\};$$

$$i, j, = 1, 2.$$

It is to be noted that $s^2 = S^2/(n-1)^2$. By a distribution, we mean the probability that $S^2 < t^2$, the derivative of this with respect to t being then the probability density, which is sometimes called the "distribution" by statistical writers.

For convenience of notation, let the two variates be x and y. The $\phi = ax^2 + 2bxy + cy^2$. But as we mean ultimately to consider the *ratio* of two generalized variances, which is a function independent of linear homogeneous transformations, we might as well consider the transformation to have been performed in advance which brings ϕ to its canonical form: for a positive definite form, $\phi = x^2 + y^2$. The required distribution is then given by

$$(4) \qquad p\ (t) = \frac{1}{(2\pi)^n} \int_R \cdots$$

$$\int e^{-\frac{1}{2}(x_1^2 + \cdots + x_n^2 + y_1^2 + \cdots + y_n^2)} dx_1 \cdots dx_n dy_1 \cdots dy_n$$

where the region of integration R is defined by the inequality:

$$(5) \qquad S^2 \equiv \Sigma (x_i - \bar{x}) \Sigma (y_i - \bar{y}) - \{\Sigma (x_i - \bar{x})(y_i - \bar{y})\}^2 < t^2;$$

$$\text{with} \quad \bar{x} = \frac{1}{n} \Sigma x_i,$$

$$\bar{y} = \frac{1}{n} \Sigma y_i.$$

The variates x and y have the sampling values $x_1, \ldots x_n$; $y_1, \ldots y_n$, which are independent, being chosen at random by hypothesis, and the formulæ (4 – 5) are then self-evident.

For the reduction of the integral, the

treatment by Uspensky for the distribution of the correlation coefficient is rigorous and can be carried out step by step. Choosing the new variables of integration as the means $\bar{x}$, $\bar{y}$, and $n-1$ each of the differences $x_i - \bar{x}$ $y_i - \bar{y}$, and performing a suitable linear homogeneous transformation, the integral in (4) is reduced to a similar one with $n-1$ in place of n, the usual loss of a degree of freedom for measuring from the sample mean. A second transformation and one integration will reduce the integral further to

$$(6) \qquad p(t) = c \int_R \cdots \int e^{-\frac{1}{2}(w_1^2 + \cdots w_{n-1}^2 + \xi_1^2 + \cdots + \xi_{n-2}^2)} dw_1 \cdots dw_{n-1} d\xi_1 \cdots d\xi_{n-2};$$

$$R: (w_1^2 + \cdots + w_{n-1}^2)(\xi_1^2 + \cdots + \xi_{n-2}^2) < t^2$$

But we have the two classical formulæ of integration:

$$(7) \quad (a): \int_0^\infty e^{-x^2 - \frac{a^2}{x^2}} dx = \frac{\sqrt{\pi}}{2} e^{-2a}$$

$$(b): \int \cdots \int_{x_1^2 + \cdots x_r^2 < a} e^{-\frac{1}{2}(x_1^2 + \cdots + x_r^2)} F(x_1^2 + \cdots + x_r^2)\, dx_1 \cdots dx_r = \frac{\pi^{\frac{r}{2}}}{\Gamma\left(\frac{r}{2}\right)} \int_0^a e^{-\frac{u}{2}} u^{\frac{r}{2}-1} F(u) du$$

These allow us at once to write down dp/dt in the form:

$$(8) \qquad \frac{dp}{dt} = c\, e^{-t}\, t^{n-3}: \text{ range } t = 0 \text{ -- } \infty.$$

This is, again, of the form of the integrand for the incomplete gamma function, and so, if we wish to find the distribution of the ratio of two independent sampling observations of S^2, we can proceed as usual. But it is clear that the exponent is not the usual number of degrees of freedom. In fact, the degrees of freedom, as is to be seen by comparing exponents with those in the usual formula, are now $2n-4$. Thus, we must use $(2n-4)^2$ as the divisor for S^2 in place of $(n-1)^2$. Finally, a last correction is necessary for the fact that we have used $S^2 < t^2$ in place of the usual distribution, which would be the probability $S^2 < t$. All of this, however, is now quite obvious, and the result can be summed up in a theorem:

If two independent samples of n, n' specimens are taken at random from a bivariate normal population, then the quantity

$$(9) \qquad z = \frac{1}{4} \log \frac{S^2}{S'^2} + \frac{1}{2} \log \frac{n'-2}{n-2} = \log \left\{ \sqrt{\frac{S}{n-2}} \Big/ \sqrt{\frac{S'}{n'-2}} \right\}.$$

has the same distribution as Fisher's z for a single variate, with the degrees of freedom $2n-4$, $2n'-4$.

The distribution was known (Wilks,[3] 478) but the adjustment for the proper number of degrees of freedom, and the possibility of using Fisher's tables, have apparently been overlooked. The rule is quite as simple as for a single variate. In the usual notation we calculate the quantity $s^2_x s^2_y (1-r^2)$, multiply by the correction factor

$$(n-1)^2/4(n-2)^2,$$

and take a *quarter* instead of a half of the natural logarithm of the ratio of two such sampling observations. Then, enter Fisher's tables of z as usual, but with the degrees of freedom $2n-4$ instead of $n-1$.

3. The results of the preceding section are not extensible to $k \geqslant 3$. The integrals do not reduce so easily, at least by any known formulæ. For example, the case $k = 3$ can be solved completely if an explicit formula for the integral from zero to infinity of $\exp -(x + a^2/x^2)$ is found. But it does not seem possible that this would allow a rigorous use to be made of the z tables.

It would be interesting to see the extended z test for $k = 2$ used for analysis of variance: say for plot experiments with two simultaneous crops sown on each plot. The test is open to the same criticisms levelled against the z test for one variate, in that it does not take the mean values into account, but tests directly on the basis of the observed variances, the hypothesis that both samples might have been drawn from the same normal population. For tests also taking the mean values into account, as in Student's t test, we have the T^2 of Hotelling and its generalizations. But for a bivariate population, the test suggested here is surely more complete than the usual method of testing the variances s^2_x, s^2_y individually, along with the correlation coefficient r.

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[1] J. L. Coolidge, *Theory of Probability*, Oxford, 1924, p. 82.

[2] J. V. Uspensky, *Introduction to the Mathematical Theory of Probability*, 1937, p. 332, *et. seq.*

[3] S. S. Wilks, "Certain Generalizations in the Analysis of Variance," *Biometrika*, 1932, **24**, 471–494.

MATHEMATICAL OBFUSCATIONS IN BIOLOGY*

BY

S. D. S. GREVAL

Mathematics and Micromathematics

THAT averages should be corrected for probability; that a rupee when tossed with the same balance and force will give as many heads as tails only when the number of tosses is large; that fluke chances turn up; and that the chances with a rupee are essentially different from those with a dice, we are pleased to know. We will even buy books and renew our acquaintance with algebra and differential calculus. This is mathematics. That figures must be plotted on complicated curves; that equations well stocked with $\int$s, d's and $\sqrt{}$'s should be constructed; and that many letters of the alphabet should be distorted or dislocated to trap and hold some elusive quantities, before we record observations on events in the lives of plants and animals, we may not consider significant. This is micromathematics. Probably Providence ruled the early cosmos with rigid mathematics even of the micro variety. The rigidity has definitely been relaxed since the birth of protoplasm. So far as its application to the activities of the protoplasm is concerned the micromathematics is a figment of the mathematicians.

Examples of Failure of even Simple Arithmetic to Account for Well-known Biological Occurrences

Mendelism is too well known to be discussed in detail here. The nearest approach that Mendel made to his 3 : 1 ratio in a lifetime, was 2·81 : 1 (Holmyard)[1] or 2·84 : 1 (Ride).[2] The latter day knowledge of the behaviour of chromosomes in the formation and fertilisation of gametes, which is a histological fact, leaves no doubt whatsoever regarding the correctness of the ratio. So far as protoplasmic activities are concerned, however, 2·81 or 2·84 must be accepted as 3. A closer approximation is not possible.

Another, even more outstanding, example of the failure of simple arithmetic occurs in immunology, in the following relationship between the toxin of the diphtheria bacillus and the anti-toxin made to neutralize the toxin:—

1. A minimal lethal dose (M.L.D.) of diphtheria toxin is the smallest amount which kills a guinea-pig weighing 250 grammes in 4 days.

2. A completely neutralized dose (L_0) is the largest amount of toxin completely neutralized by 1 unit of diphtheria anti-toxin. It does not kill the guinea-pig.

3. A re-toxicated dose (L_+) is the smallest amount of toxin, which when mixed with 1 unit of diphtheria anti-toxin just kills the standard animal in the standard time. It acts like 1 M.L.D.

Dose 3 *minus* Dose 2 should be equal to Dose 1

or

L_+ *minus* L_0 should equal 1 M.L.D.

In actual practice $L_+ - L_0 = 8$ to 12 M.L.D. (Hewlett and McIntosh).[3]

One unit of the anti-toxin neutralizes 100 M.L.D.'s (Ehrlich's original standard). The excess, therefore, is 7 to 11 per cent.

Explanations of this anomaly, which are 'probably' correct, have been given. The fact, however, remains that the same looseness of relationship exists between all antigens and anti-bodies (including toxins and anti-toxins) regardless of the method used in testing.

The Figment of the Mathematicians is not used even in Important Human Activities of Peace and War

The producer of the raw material mostly works without machinery and has little scope for mathematical refinements. The manufacturer of goods works with machinery yet uses very little mathematics. The seller of goods prefers advertisement and *creation of demands* to the statistical analysis of the *existing demands*.

In sport, judging of form, handicapping or even forecasting of events by professional advisers is not based on a complicated system of calculation at all. If the existing system were faulty the micromathematicians would have at their disposal the wealth of all the totalisators in the world. Such is not the

* Abstracted and amended from an article by the author (Greval, 1940) in the *Indian Medical Gazette*, 1940, 75.

case. They have not fared any better than ordinary folks even at Monte Carlo where the protoplasmic interference with the turn of events is minimal.

When the leaders of nations choose between peace and war they do not do so in an atmosphere of higher and pure mathematics.

The High Threshold of Life Defies Micromathematics

The *threshold* is familiar to physiologists. Vital receptors take no cognizance of what comes to them unless it is worth considering. That is why micro-mathematical quantities are without effect. Even the non-living products of living organisms are imbued with the same peculiarity of reaction. The physical basis of the peculiarity in either case is the highly complicated structure of the protein molecule.

Thresholds are known in the behaviour of non-living matter. Flow of electric currents shows a hesitancy under certain conditions. Certain chemical reactions appear to sit on the fence for a while. The *quantum* is essentially a threshold effect. Biological thresholds are much higher.

When a case of pneumonia approaches the crisis the physician in attendance may visualize the psyche perched precariously on a very high threshold. It will either tumble back into the weary body or glide forth into the Great Beyond. Micromathematics does not reach the threshold and does not help in the treatment or prognosis.

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[1] Holmyard, E. J., *Biology for Everyman* by the Late Sir J. Arthur Thomson (J. M. Dent & Sons, Ltd., London), 1934.

[2] Ride, L., *Genetics and the Clinician* (John Wright & Sons, Ltd., Bristol), 1938.

[3] Hewlett, R. T. and McIntosh, J., *A Manual of Bacteriology* (J. & A. Churchill, London), 1932.

A PRELIMINARY NOTE ON THE SEVERE MEXICAN EARTHQUAKE OF APRIL 15, 1941

BY

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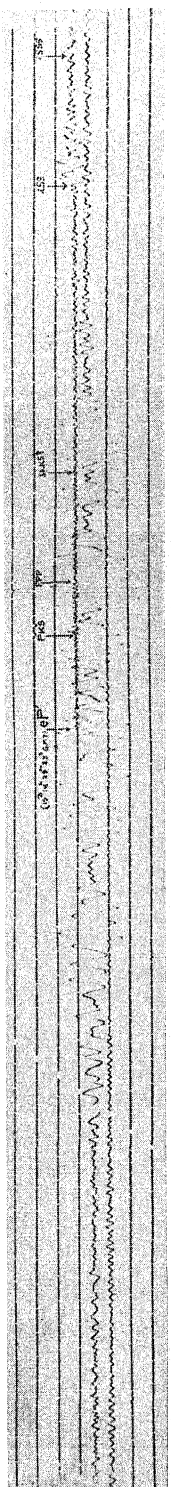
AN earthquake shock of severe intensity rocked Mexico at $19^h\ 29^m$ Greenwich Mean Time (roughly about 13^h Mexican Standard Time) on Tuesday, the 15th April 1941. It is too early to get complete reports of the extent of area affected and the amount of damage caused; but the reports so far available from Mexico City state that the number of persons killed there exceeds 250 and that two towns, *viz.*, Tecatelan and Tuxpan in the State of Jabisco, have been wiped out. Many persons are reported to have been killed in the villages along the coast. Nearly three-fourths of the houses in Colima City have been either damaged or destroyed. A report from Vichy, supposed to be based on a message from Mexico City, states that most of the 15,000 inhabitants of the city of Colig are believed to have been either killed or injured. The volcanic group near Colima is reported to be in eruption and a tidal wave along the Jabisco coast has caused destruction to life and property in many villages. It would naturally take some days before the final casualty list will be available to us, but it is expected to be fairly heavy, judging from the nature of destruction.

Past history shows that the Mexican region is liable to experience severe earthquakes occasionally. During the last 13 years this region has felt as many as seven shocks of severe intensity including the present one. The extent of damage to life and property during these shocks varied to different degrees. The dates of occurrences of these shocks together with a brief description of the extent of damage done are given in Table I.

According to Milne's Catalogue[1] of Destructive Earthquakes, the total number of destructive earthquakes of intensity III (those that destroy towns and desolate districts) during the 17th, 18th and 19th centuries were 11, 8 and 16 respectively.

Epicentre of the Earthquake.—The seismographs at all the Seismic Stations of the India Meteorological Department, namely Bombay, Calcutta, Agra and Kodaikanal, as also those of the Nizamiah Observatory at Begumpet and the Haig Observatory at Dehra Dun have recorded this shock as one of great intensity. All the four departmental Seismic Centres have recorded P' as the first movement and that with an 'emersio'. SS is clearly recorded with an 'impetus' at all the four stations; the calculation of the



The Great Mexican Earthquake of April 15, 1941. Colaba Seismogram (Milne-Shaw Seismograph, E-W. Compt.).

TABLE I

Date of Earthquke	Intensity of shock as reported by the Press	Brief details of the extent of damage done	REMARKS
1931 Jan. 15	Violent (sharpest tremors ever experienced)	119 killed. Damage to buildings and property	
1932 June 3	Very severe	Widespread damage; more than 300 killed (reported to be the worst shock during the decade)	Shock of very great intensity by Bombay records
1934 Jan. 28	Severe	Many buildings damaged and several people injured	
1934 Sept. 19	Severe	9 killed and 200 injured	Phase movements in Bombay. Seismographs too feeble to be identified
1937 Dec. 23	Severe	Several houses severely shaken	
1940 May 19 or 20	Severe	9 dead and several injured	Movements too feeble in Bombay, records to be identified
1941 April 15	Severe	More than 250 killed and several towns demolished	Further details lacking at the time of going to Press

epicentral distances has been based on the SS–P′ difference. The times of P′ and SS as reported by these centres together with the calculated Δ (SS–P′) are given in Table II.

TABLE II

Station	P′ time (G M T.)	SS time (G.M.T.)	Δ
	H M S	H M S	°
Agra	19 29 14	19 49 29	134·1
Bombay	19 29 23	19 51 05	142·6
Calcutta	19 29 09	19 51 06	144·1
Kodaikanal	19 29 44	19 52 27	148·9

The tentative epicentre based on the above data with slight adjustments came to Lat. 15° N. and Long. 92° W., to the south-eastern border of Mexico.

Depth of Focus.—Without the seismograms from other centres no precise determination of the depth of focus of the earthquake is possible. The nature of the Colaba records, however, suggests a depth of focus in the neighbourhood of 120 Km.

During recent years (1932–39) this Mexican area has experienced Deep Focus Shocks[2] with epicentres varying between Lat. 12° N.; Long. 87·50° W.; and Lat. 18·75° N.; Long. 101·75° W. The depth in these cases varied from 70 Km. to 150 Km. Gutenberg and Richter have opined[3] that intermediate shocks (those with depths between 60 Km. and 250 Km.) occur in Mexico.

Magnitude and Energy.—Using the formulæ[4] $\log E_0 = \log E - 2M$ and $M = \log a - \log A_0 - 2{\cdot}5$, the magnitude and energy of the present Mexican 'Quake come to 7·7 and 10^{22} ergs respectively. The energy is equal to that of the Chilean shock of January 25, 1939, and ten times that of the Anatolian 'Quake of December 27, 1939.

As already stated, the telegraphic reports from the Departmental Seismic Centres point to a region near the south-east border of Mexico. In the absence of detailed reports regarding the extent of damage done, it is difficult to judge the preciseness of the tentative determination of the epicentre.

The Milne-Shaw Seismogram (E.–W. Compt.) of the Mexican Earthquake as recorded at the Bombay (Colaba) Observatory is reproduced in the figure.

[1] *Br. Adm Rept.*, 1911, p. 679.
[2] Gutenberg and Richter, *Bull. of Geol. Soc. of America*, **50**, p 1514.
[3] *Internal Constitution of the Earth*, p. 293.
[4] Gutenberg and Richter, *Gerlands B. Z. Geophysik*, **47**, p. 122.

OBITUARY

PROF. E. W. MACBRIDE

THE death of Prof. E. W. MacBride, F.R.S., Emeritus Professor of Zoology in the University of London on November 17, 1940, at the age of 73, has removed an outstanding personality from the zoological world.

Born in Belfast, Ireland, on 12th December 1866, he had his early education at Queen's College, Belfast, and in 1889 he graduated from London obtaining the University Scholarship in Zoology. He went to Cambridge where he distinguished himself and won the Exhibition and the Foundation Scholarship of his College, St. John's. His debating powers secured him the Presidentship of the Cambridge Union in 1891. He worked at the Zoological Station at Naples under Anton Dohrn, the founder and director of the Station during 1891–92. In 1892, he was appointed University Demonstrator in Animal Morphology at Cambridge and became Fellow of St. John's College next year. By this time, his researches had won for him international recognition and reputation and he was the first recipient of the Washington Medal for Biological Research. He left for Montreal in Canada in 1897, having been selected as the first Strathcova Professor of Zoology in the McGill University. In 1901, his first book written jointly with his Cambridge colleague Shepley appeared. This text-book of zoology was a success and had run through several editions since. In 1905, he was elected a Fellow of the Royal Society and next year (1906), the *Cambridge Natural History*, Vol. I, appeared, with the section on Echinodermata written by Prof. MacBride. Though he married in Canada a daughter of late Francis Henry Chrysler, K.C., of Ottawa, his zeal for science frequently took him to England, to renew his investigation and researches, until in 1909 he finally resigned his post and returned to England. He is next seen engaged in the heavy task of writing a comprehensive text-book of Invertebrate Embryology which, published in 1914, is still the standard text-book in the English language. This biggest achievement of his, he generously dedicated to his teacher Adam Sedgwick, whom he succeeded, on his pre-mature death, in the Imperial College of Science in 1913. It was a matter of great satisfaction and pride to him that he should have succeeded Adam Sedgwick in a place which was held, prior to Sedgwick by Sedgwick's teacher, the famous Thomas Huxley. Prof. MacBride used to delight on this genealogy. For over 21 years, till his retirement in 1934, he held the post in the Imperial College and turned out from his Huxley Laboratory a stream of research which honours the pages of scientific journals in England. Even after his retirement, we find him attending the Imperial College as Emeritus Professor of the University and guiding research at his old laboratory.

We in India, have reason particularly to mourn the death of Prof. MacBride. Apart from books which are in daily use in Colleges he has been the *guru* of several brilliant students who now occupy important zoological positions in India. Almost every province in India which has zoological activities can claim a pupil of Prof. MacBride in its service. Bombay, Madras, Calcutta, Aligarh, Travancore, Hyderabad can each claim one or more zoologists who had been Prof. MacBride's pupils. There is no other professor in England who can claim to have turned out as many Indian zoologists as Prof. MacBride has. It may well be claimed for him therefore that the recent zoological progress in this country owes a deep debt of gratitude to him.

Prof. MacBride was a most charming and inspiring personality that infused the young minds with a real thirst and spirit for research.

S. G. M. R.

LETTERS TO THE EDITOR

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ULTRA-VIOLET BAND SPECTRUM OF HgBr

In continuation of the work on HgCl bands,[1] the ultra-violet band systems of the homologous molecules, HgBr and HgI have been investigated under similar experimental conditions. The characteristic bands between λ2900 and λ2650, designated as the Class II system and suggested by Wieland[2] as belonging to the triatomic molecule $HgBr_2$, have been ascribed by the author to the diatomic molecule HgBr and a vibrational analysis has been obtained. The constants determined for the band heads of $Hg^{202}Br^{81}$ are

ω_e'	= 459·0 cm.$^{-1}$	ν_e (mol)	= 34537·8 cm.$^{-1}$
ω_e''	= 372·3 ,,	ν (atom)	= 4·92 volts
$x'_e\,\omega_e'$	= 3·6 ,,	D′	= 1·81 ,,
$x''_e\,\omega_e''$	= 3·8 ,,	D″	= 1·15 ,,

The assignment of the quantum numbers is confirmed by observations of the isotopic heads due to $Hg^{202}Br^{79}$, for which the agreement between the observed and calculated positions is very close. The electronic transition giving rise to the band system is probably $^2\Sigma - {}^2\Sigma$ with negligible spin doubling, the dissociation products being $Hg(^1S) + Br(^2P)$ and $Hg(^3P) + Br(^2P)$ for the two electronic states. A full account of the work will be published shortly.

M. G. Sastry.

Andhra University,
Waltair,
March 22, 1941.

[1] *Curr. Sci.*, 1941, **10**, 669.
[2] *Helv. Acta Phy.*, 1929, **2**, 46, 77.

CRYSTAL STRUCTURE OF COUMARIN

Coumarin crystallises in the orthorhombic system with the axial ratio 0·9833 : 1 : 0·3696.[1] The dimensions of the unit cell obtained from measurements of a number of rotation photographs about the three crystallographic axes, using Cu K_α radiation, are 15·44, 7·92 and 5·66 Å. $a : 2b : c$ is in agreement with the axial ratio quoted above. In the rotation photographs, spots of the type *hkl* are present in all orders while *okl* is halved if *k* is odd and *hko* is halved if *h* is odd. The possible space-groups are therefore V_h'' and C_{2v}^5, the former being a holohedral group and the latter a hemimorphic hemihedral one. Since coumarin exhibits hemimorphism about the *b* axis[1] it is to be concluded that C_{2v}^5 is the correct space-group.

Examination under a polarising microscope with convergent light reveals that the *c* axis is normal to the optic axial plane. The crystal is positive and the acute bisectrix is parallel to the *b* axis. This would mean that the vibration directions for the largest, mean and smallest refractive indices correspond to the *a*, *c* and *b* axes respectively.

The diamagnetic anisotropy of the crystal, determined for me by Dr. P. Nilakantan, is as follows:

$$(\chi_a - \chi_c)_M = 31{\cdot}8\times10^{-6},\ (\chi_a - \chi_b)_M = 109\times10^{-6}$$
$$\text{and } (\chi_c - \chi_b)_M = 79{\cdot}0\times10^{-6}.$$

Hence the anisotropy in the *ac* plane is comparatively small and $\chi_b > \chi_c > \chi_a$.

From the optical and magnetic data it is to be concluded that the molecule is orientated in the unit cell with its plane parallel or nearly so to the *ac* plane. Also the long axis of the molecule is parallel or nearly so to the *a* axis. A complete analysis of the crystal structure is in progress.

S. RAMA SWAMY.

Department of Physics,
Central College, Bangalore,
April 7, 1941.

[1] A. Cathrein, *Zs. Krist.*, **11**, p. 402.

OPTICAL SENSITISATION AND PHOTOVOLTAIC EFFECT OF DYES

VARIOUS attempts have been made from time to time to connect optical sensitisation with other physico-chemical properties. Zchodro[1] found complete correlation between light absorption and photo-conductance of three sensitising dyes, cyanine, pinaverdol and pinachrome. Bancroft, Ackerman and Gallagher[2] have connected the sensitising power of a dye with its capacity as a halogen acceptor. Kornfeld[3] thinks there may be some correlation between fluorescence and optical sensitisation and suggests an investigation of this property in sensitised emulsions. Leermakers, Carroll and Staud[4] have shown that absorption and optical sensitisation run parallel. A close comparison of the absorption and sensitisation of a photographic plate by the two dyes, Eosin and Erythrosin, reveals the fact that the maximum of sensitisation does not coincide with the region of maximum absorption of the dye, but is displaced a few wave-lengths to the red. It has however been stated, on the basis of the generally known fact that the absorption of a dye is appreciably altered by the properties of the solvent, what is of account in determining its sensitising action is not its individual absorption, but of the complex it may form with the sensitive emulsion. (This complex is in the nature of an adsorption complex and in some instances a peculiar edge-on adsorption or a nematic state has been assumed with entirely different properties of absorption.)[5]

I have shown elsewhere with reference to Erythrosin[6] that the maximum of photo-voltaic effect in aqueous solutions of the dye (where obviously no complicated adsorption phenomena may come into play) occurs in a region shifted a few wave-lengths to the red from the absorption head and does coincide with the region of maximum sensitisation of the photographic plate. At the same time I ventured the suggestion that the same factors probably come into play in giving rise to the two effects. I have since been able to extend these observations on three more dyes[7]—Methylene blue, Methyl green and Malachite green—all of which possess a second band of absorption in the less refrangible part of the visible spectrum. In every case may be seen two maxima of photo-potential corresponding to the two absorption bands and the wave-length displacement or shift is also unmistakably present. The sensitising action of these dyes on the light sensitive compound, HS.Hg.CNS., has already been noted[8] and a comparison of the photo-potential with the amount of optical sensitisation along the spectrum shows a definite parallelism, which is indeed more than a mere coincidence and suggests identity of origin for the two effects. The accompanying table illustrates this point.

TABLE I

	Absorption	Sensitisation	Region of maximum photo-potential
	μμ	μμ	μμ
Erythrosin ..	455—560	560—600	580
Chrysoidin ..	360—540	..	546
Methyl green ..	550—650	580—690	580—690
Malachite green	from 550	530—620	615
Methylene blue	540—615 & 665—695	530—600	580

N B.—In the case of the last three dyes the absorption in the blue-violet has not been given. Against sensitisation is noted only the region where it is very appreciable and amounts to a second maximum. In a general sort of way all the three dyes sensitise upto 700μμ.

One may then draw the very reasonable conclusion that the mechanism by which optical sensitisation is produced is not very different from that by which photo-voltaic effects are produced. On the latter question fairly decisive evidence is available.. Russell[9] and Ghosh,[10] more particularly the latter, pictured a primary or initial photo-chemical activation of the dye molecules, the photo-E.M.F. resulting from an impact of such activated molecules on the electrode surface. This picture coupled with that of deactivation by collision before impact enabled Ghosh to predict a number of characteristics of this photo-potential, *e.g.*, time lag, variation with intensity, etc., all of which are borne out by the data of Rule[11] on fluorescein and my own on no less than five dyes of widely differing character. In short, evidence has accumulated to point to a preliminary activation of the dye molecule by absorption of light. Photo E.M.F. or sensitisation is a secondary phenomenon arising from an impact of this activated dye molecule with the electrode or the sensitive emulsion (or other light sensitive body). Why in both cases the maximum activity is slightly shifted from that of maximum absorption, is a question which cannot be answered at the moment.

The phenomenon of desensitisation has similarly been much discussed. It has early been recognised that desensitisation is a property common to all sensitisers at higher concentrations. Desensitisation in all such cases refers only to the property by which the substance is rendered insensitive to the rays which are ordinarily active. The question has been probed if desensitisation does not mean sensitisation to the simple Herschel effect.[3] Weber[12] noticed that in a sensitised plate desensitising showed more strongly in the sensitised spectral region than in the absorption region of silver bromide. During experiments on sensitisation of phototropic changes[8] evidence has been recorded of the same dye and in the same concentration, sensitising the forward darkening process as well as the reverse bleaching process in a particular spectral region, although with much different efficiencies. The bleaching is a much slower process. On a close examination it shows that these dyes possess strong absorption in the region of normal reversal of the sensitised compound. Of significance in this connection is also the fact that such of the dyes which do not absorb the normal bleaching rays, *e.g.*, eosin and erythrosin, sensitise only the darkening process.

There is therefore strong reason for concluding that sensitisation and desensitisation are not two different phenomena, but constitute essentially a single phenomenon in which sensitisation may occur of one of two opposed processes or of both depending on the nature of the sensitiser. In the latter case, an apparent equilibrium between the two processes is established and the rôle of such dyes may be compared to that of catalysts in ordinary chemical reactions, provided however the comparison is pressed no further. Experiments are in progress on the behaviour of sensitised phototropic compounds (conductivity and voltaic activity) as well as silver halides which are calculated to throw further light on this complicated mechanism of optical sensitisation.

BH. S. V. RAGHAVA RAO.

Andhra University,
Waltair,
March 14, 1941.

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1 *J. Chim. Phys.*, 1929, **26,** 59.
2 *Proc. Nat. Acad. Sci., U. S.*, 1931, **17,** 407.
3 *J. Phys. Chem.*, 1938, **42,** 807.
4 *J. Chem. Phy.*, 1937, **5,** 893.
5 Kornfeld, *loc cit.*
6 *J. Phys. Chem.*, 1934, **38,** 693
7 Under publication.
8 *J. Phys. Chem.*, 1928, **32,** 1354.
9 *Phys. Rev.*, 1928, **32,** 667.
10 *Z. Physikal Chem.*, 1929, **3,** 419.
11 *Proc. Nat. Acad. Sci., U. S.*, 1928, **14,** 272.
12 *Z. Wiss. Photo*, 1936, **35,** 124; 1937, **36,** 1.

PHOTOVOLTAIC EFFECTS IN DYE SOLUTIONS

CONTINUING former work[1] on aqueous solutions of Erythrosin and Chrysoidine, three new dyes, whose absorption extends well into the red have been investigated—Methylene blue, Methyl green and Malachite green. These dye solutions give rise to two absorption maxima and it should be interesting to note if the photo-potential also exhibits similar maxima. With reference to their photo-sensitising action it may be mentioned that when dyed on the phototropic substance, HS.Hg.CNS, a second maximum of darkening is noticed in the orange-red, the first in all cases practically coinciding with, or extending on either side by a short region of that due to the substance itself. These investigations yielded results similar in every way to those recorded before and confirmed the conclusions then arrived at, as will be shown presently. Further a far-reaching parallelism between the development of photo-potential and optical sensitisation may be traced which forms the subject of another communication.

A description of the apparatus will appear elsewhere in a fuller account of the work. It is however necessary to add that a vacuum type of mercury arc served as the source of illumination and potentials were measured with a vacuum tube volt-meter, in which the lighted electrode was connected directly to the grid and the dark electrode was biassed from the negative end of the filament to the potential of the free (floating) grid. Under these conditions the grid current being actually zero at the start and negligibly small at the end of a run, polarisation of the cell does not occur and the zero of the instrument does not drift.

The rise and fall of potential on insolation and cutting off the light, its variation with the concentration of the dye and intensity of illumination, do exhibit complete similarity to the dyes already examined. In the composite light of the mercury arc, Methylene blue develops a potential of 12 m.v. at a concentration of 0·0009 mg. per ml., Methyl green 10 m.v. at 0·0024 mg., and Malachite green 11 m.v. at 0·0015 mg. per ml. Of interest however is the variation of the photo-potential with the wave-length of the exciting radiation. The accompanying table gives these values corrected for the transmission factors of the spectral filters employed and the energy distribution of the mercury arc. It is particularly noteworthy that all the dyes develop maxima of photo-potential corresponding to their absorption maxima in the different regions of the spectrum and shifted therefrom by a few wave-lengths to the red.

Calculated photo-potential and wave-length

	Methyl green	Malachite green	Methylene blue
	m.v.	m.v.	m.v.
Composite light ..	10,0	11,0	12,0
436 $\mu\mu$ ..	7,0	4,0	7,5
546 ..	2,0	6,0	6,0
577–9 ..	8,0	7,0	14,0
615 ..	11,0	12,5	10,0
690 ..	9,0	7,0	8,0
700 ..	3,5	4,0	5,0

BH. S. V. RAGHAVA RAO.
Andhra University,
Waltair,
March 14, 1941.

[1] *J. Phys. Chem.*, 1934, **38**, 693.

VERIFICATION OF KAUFMANN CONDITION, FOR ARC DISCHARGE IN MERCURY

KAUFMANN[1] derived the condition for the stability in glow discharge. He showed that the *limiting point* on the falling characteristic of voltage against current in a glow discharge which will give the *smallest current* under which the glow could be maintained depends on the external resistance W in the circuit. His condition can be expressed as $W = -\tan \beta$

where β is the angle which the tangent to the characteristic at the point makes with the current axis.

In this note we wish to show that this condition holds and can be verified in the case of *arc* discharge in mercury.

The mercury arc characteristic as obtained with a mercury lamp of the high vacuum type is a straight one, in which the voltage across the arc rises with increase of current flowing through, *i.e.*, it is a rising characteristic as shown by Henri[2] as well as Daniels and Heidt.[3] Therefore there is no question of the Kaufmann condition being fulfilled here, at all, as tan β is positive and no falling part in the characteristic of mercury was known.

All efforts by us to get a falling part in the characteristic proved futile in highly evacuated arc lamps of mercury. If however a small amount of air is introduced, so that the air pressure in the arc space is about 0·5 mm. or more, then it is possible to get the falling part. It becomes more and more prominent as the pressure is increased.[4] The development of the negative characteristic can be brought about also by cooling the arc for example by blowing currents of air from different distances, with an electric table fan, provided the pressure (inside air pressure) is not lower than about 0·5 mm. of mercury. From such curves we can obtain the tangents at different points.

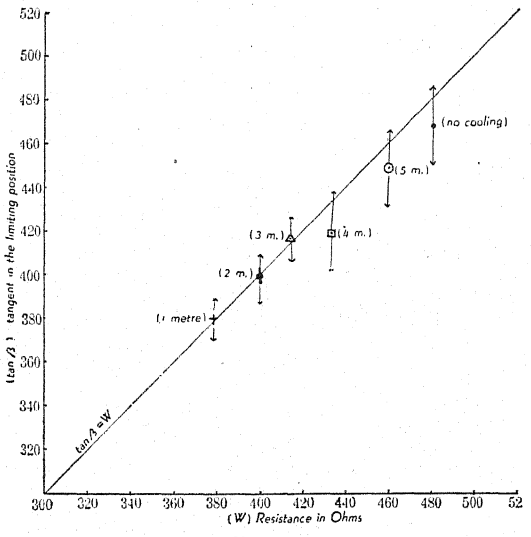

FIG. 1
Verification of Kaufmann condition

The figure above shows the values of the tangents as ordinates obtained for the limiting points when an arc is maintained in a mercury arc lamp made out of soft glass, and cooled by the fan to different amounts. The abscissae show the actual values of the resistance in the external circuit. The tangents obtained with coolings at distances of fan of 1, 2, 3, 4 and 5 metres, and also without any cooling by fan are shown in the figure. The deviations in the values of the tangents under a particular condition are indicated by arrows. The points fall on a straight line inclined at 45° to the axes, showing that the tangent condition is strictly fulfilled. These points show that their value increases with decrease of cooling, *i.e.*, by removing the fan farther and farther away. We also verified this condition with two different mercury lamps.

B. DASANNACHARYA.
C. DAKSHINAMURTI.

Department of Physics,
Benares Hindu University,
March 26, 1941.

[1] W. Kaufmann, *Ann. d Phys.*, 1900, **2**, 158.

[2] Henri, *Comptes Rendus*, 1911, **153**, 426, quoted in the paper by Lewis Reeve; *J. Phys. Chem.*, 1925, **29**, 39.

[3] F. Daniels and L. G. Heidt., *J. Am. Chem. Soc.*, 1932, **54**, 2381.

[4] See B. Dasannacharya and C. Dakshinamurti, *Curr. Sci.*, 1941, **10**, 166.

MODIFIED EQUATIONS FOR ADSORPTION AND BASE-EXCHANGE IN SOILS*

WHEN a calcium soil is treated with a solution of Na_2CO_3 the following base-exchange reaction takes place:

$$CaZ + Na_2CO_3 \rightleftharpoons Na_2Z + CaCO_3$$

This equation however does not express all the significant factors connected with the reaction.

*[This work is being done under the auspices of the Irrigation Department (Research Section) of the U P. Government.]

Firstly there is adsorption of sodium carbonate by the soil, and secondly there is the base exchange; the two are related but not necessarily equivalent. For example the sodium carbonate adsorbed is not equivalent to but is generally greater than the calcium exchanged. Hence the two aspects may be treated separately; the first may be spoken of as general adsorption, and the second leading to the base exchange as "exchange adsorption".

In a number of experiments it was found that the adsorption of sodium carbonate by Ca-soils was governed by the well-known Freundlich equation:

$$y = aC^{\frac{1}{n}}$$

where y is the quantity of sodium carbonate adsorbed, C the equilibrium concentration, and 'a' and 'n' constants.

In nine soils examined (Table I) it was found that 'n' varied within narrow limits (0·8 to 1·1) while 'a' varied within wide limits. The latter is presumably a characteristic of the particular soil.

When the constant 'a' is plotted against the base-exchange capacity 'B' we obtain a parabolic curve, and that it is a parabola is further confirmed by the fact that when 'a' is plotted against 'B^2' we get a straight line (Fig. 1). Thus it is seen that the constant 'a' in Freundlich's equation seems to be a function of the base-exchange capacity of the soil. The modified equation therefore is:

$$y = kB^2C^{\frac{1}{n}}$$

The average value of n comes to 0·903, and that of k to 31×10^{-5} for nine soils examined (base-exchange capacity of these soils varied from 7·9 to 20·52 m.e.). Hence the adsorption formula may finally be stated as:

$$y = 31 \times 10^{-5}B^2C^{\frac{1}{n}}$$

[A similar attempt to connect base-exchange capacity with adsorption of K^+ and NH_4^+ ions by soils was made by Fudge[1] where he has given the values of $\frac{a}{B}$ which however is not a constant but is of the same order of magnitude, while $\frac{a}{B^2}$ gives still more varying results.]

The exchange adsorption does not follow Freundlich's rule. A number of equations have been proposed by various workers.[2] Two of these equations, *viz.*:

(1) $x = \frac{hC}{1+bC}$ (Langmuir's)

(2) $x = \frac{SI}{I+K}$ (Vageler's)

x = base exchanged
C = equilibrium concentration
I = initial concn.
h, b, K, S, constants.

TABLE I

Soil No.	Mechanical Clay %	Composition Silt %	Base exchange capacity m.e. (B)	a	n	$a/B^2 \times 10^{-5}$
3	52·43	39·20	13·40	·0497	1·110	28·0
12	27·44	50·25	14·80	·0721	·912	32·6
9	16·53	23·08	10·00	·0352	·816	35·2
4	6·00	18·50	7·90	·0186	·816	29·0
5	27·60	58·90	20·52	·1350	·924	32·0
6	26·60	58·90	11·60	·0404	·823	30·0
10	24·53	44·24	16·60	·0854	·924	31·0
13	21·85	17·36	9·88	·0303	·812	31·0
16	26·32	21·24	7·11	·0160	·824	31·7

TABLE II

(*Soil* 12; *Clay* 27·44%; *Silt* 50·25%; B 14·80)

1 Exchangeable Ca exchanged (observed)	Calculated by the formulæ			
	2 $x=\frac{hC}{1+bC}$	3 $x=\frac{SI}{1+K}$	4 $x=\frac{BU}{1+C'}$	5 $x=\frac{\mu+IB}{\lambda+I}$
·80	(·80)	(·80)	(·80)	(·80)
·88	·867	·908	·949	·883
·96	·953	1·050	1·091	·965
1·05	·992	1·092	1·239	1·053
1·12	1·000	1·172	1·379	1·125
1·21	1·158	1·240	1·506	1·123
1·40	(1·40)	(1·40)	(1·75)	(1·40)

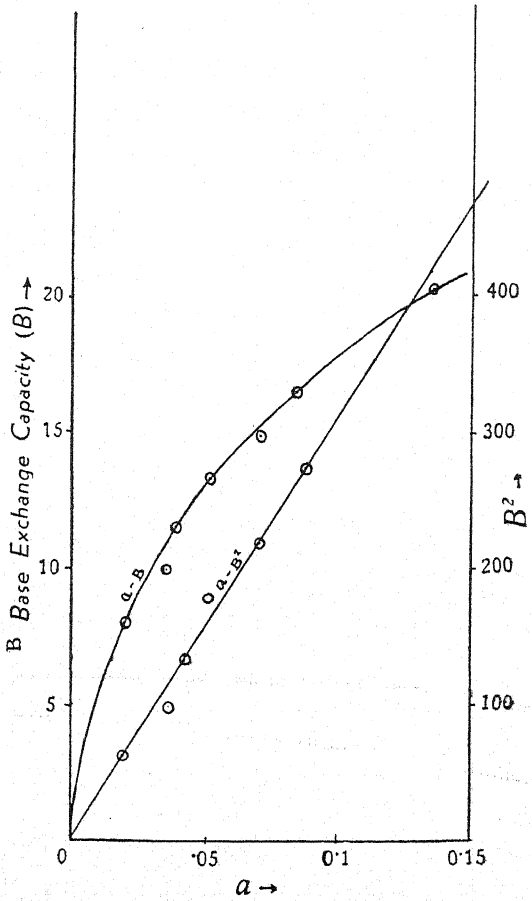

FIG. 1

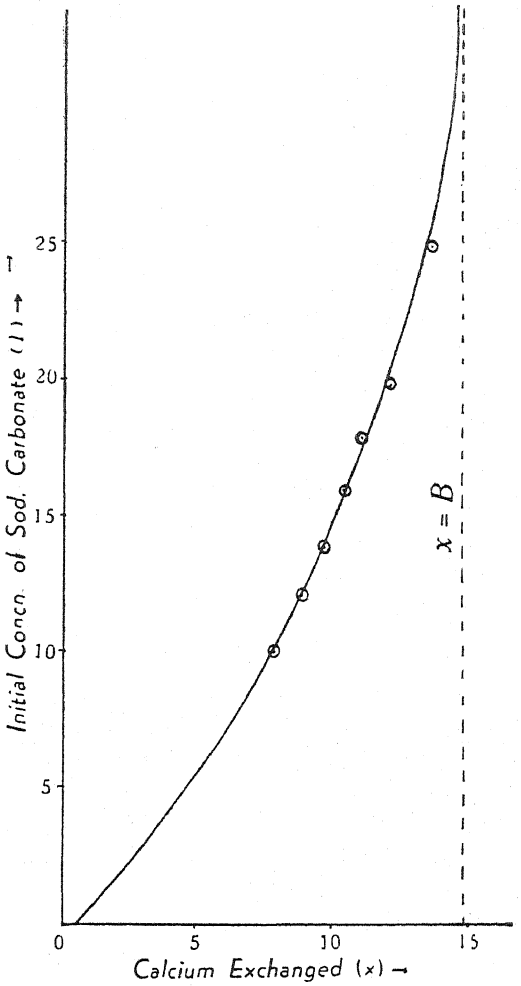

FIG. 2

have been examined here. One typical result is given in the following table:

Column No. 4 gives values for an equation similar to that of Vageler but the constant S has been replaced by B the base-exchange capacity. The values suggest that another constant is required and hence the equation in the last column.

In six soils examined so far the new equation has been found to be in better agreement with observations, while Vageler's equation is the next best. The merit of the new equation is that it takes account of B, the base-exchange capacity, an important characteristic of the soil.

When I (initial concentration of absorbent

Na_2CO_3) is plotted against x (the Ca exchanged) we get the curve (Fig. 2). In the graph the line $x = B$ (base-exchange capacity) is an asymptote of the curve (I, x) which has been confirmed by experimental results also.

Langmuir's and Vageler's equations were found to be not applicable at very low or very high concentrations, while the modified equation:

$$x = \frac{\mu + IB}{\lambda + I}$$

x = Ca exchanged
I = initial concn. of Na_2CO_3
B = base-exchange capacity of the soil.
λ, μ constants.

is applicable within wide limits.

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M. R. NAYAR.

Lucknow University,
April 2, 1941.

THE EFFICIENCY OF SOME SPECIAL PETROLEUM FRACTIONS AS WATER "ENTRAINERS" IN THE INDUSTRIAL DEHYDRATION OF ETHYL ALCOHOL

BENZENE is the common liquid used as a water entrainer in the manufacture of absolute alcohol. The use of some petroleum hydrocarbons along with benzene was first suggested by Guinot[1] and since used frequently as a complement of benzene in the azeotropic process of absolute alcohol manufacture.

A very cheap source of water entrainers for the dehydration of 96 per cent. ethyl alcohol which can displace benzene, a relatively costly material, is the petroleum hydrocarbons. For example, *n*-hexane, *cyclo*-hexane, *n*-heptane and *cyclo*-hexadiene and many other homologues form ternary azeotropic mixtures with alcohol and water. *N*-hexane forms the ternary mixture at 56·6° C. and *cyclo*-hexane at 62·1° C. In fact, such low boiling points are really advantageous in the smooth working of the azeotropic process. But, the isolation of these individual hydrocarbons from the petroleum products is rather a costly and an arduous task. This was probably the reason why the use of such petroleum fractions which contain as much as possible of the useful hydrocarbon constituents, was suggested to be used along with benzene in large-scale operations.

This investigation was taken up with a view to find out the efficiency of two such special fractions of petrol, one of continental source and the other of indigenous origin, used in the Mandya Distillery.

By efficiency of an entrainer is meant chiefly, pounds of water withdrawn per pound of the entrainer used. Besides this, factors like the relative volumes of top and bottom layers of the ternary mixture distillate, the distribution of water in the two layers and the formation of binary mixtures interfering with the formation of the ternary mixture are also important.

The amount of water entrained is evaluated by determining the composition of the ternary azeotropic mixture. The middle point method[2] of determining the composition of the azeotropic mixture of petrol, alcohol and water, is not practicable on account of the very complex nature of petrol. The method adopted in this investigation was this:—When a mixture of petrol, alcohol and water forming the ternary mixture of minimum boiling point is distilled, the separation may take place, theoretically in 13 ways.[3] Commonly, 5 cases are met with and they are the following: (i) P.A.W. (first fraction); A.W. (second fraction); and W. (residue). (ii) P.A.W.; P.W.; W. (iii) P.A.W.; A.P.; and A. (iv) P.A.W.; P.W.; and P. (v) P.A.W.; A.P.; and P.*

About 200 c.c. of the mixture in each case, as given in Table I, are distilled at a uniform rate of about 40–45 drops per minute, with a 7-pear still head. The first fraction of the distillate is the ternary mixture and the transition from the ternary to the binary mixture is evidenced by the fact that the last drop of distillate of the ternary mixture, which will be turbid, becomes suddenly and definitely clear and also by the rapid rise in temperature. The ternary distillate thus collected is diluted with an equal quantity of distilled water, a little quantity of common salt added, when all the petrol separates as a top layer. After repeated

* (P = Petrol, A = Alcohol and W = Water.)

washing of the layer its weight is determined. The lower layer of alcoholic solution is then distilled and the alcohol determined by a hydrometer. Water is obtained by difference.

Table I shows the composition of the azeotropic mixtures of two special fractions of petrol (denoted by P_1 and P_2).

water, and from Table II it is apparent that one lb. of benzene should withdraw 0·098 lb. of water. The ternary azeotropic mixture of P.A.W. when condensed separates into two layers. The percentage by volume of the two layers at 30° C. is given in Table III. The upper layer which forms about 43 to 44 per

TABLE I

Sample P_1: Sp. gr. 0·732 at 15° C. Ref. Index N_D^{27} 1·403. Boiling range = 95%/100° C.

Weights taken (Grms.)	Case 1	2	3	4	5	
Petrol	64·38	93·99	79·52	108·02	95·57	
Alcohol	54·41	31·11	65·96	31·71	50·67	
Water	39·84	29·87	5·48	9·97	5·48	
Total ..	158·63	154·97	150·96	149·70	151·72	
Wt. of ternary mixture ..	100·31	93·71	100·4	98·77	101·91	
Composition per cent. by weight (Atm. pressure = 700 mm.)						Average
Petrol	61·79	62·76	62·82	62·37	63·02	62·55
Alcohol	31·86	31·41	31·58	32·10	31·66	31·73
Water	6·35	5·83	5·60	5·53	5·32	5·72

Sample P_2: Sp. gr. 0·760 at 15° C. Ref. Index N_D^{27} 1·415. Boiling range = 90%/110° C.

Petrol	62·51	92·50	80·18	110·55	101·15	
Alcohol	50·80	31·23	65·44	29·93	42·73	
Water	49·77	34·82	6·22	10·00	6·22	
Total ..	163·08	158·55	151·84	150·48	150·10	
Wt. of ternary mixture ..	102·23	100·32	95·64	103·21	103·58	
Composition per cent. by weight (Atm. pressure = 700 mm.)						
Petrol	63·36	62·63	60·80	61·09	63·48	62·27
Alcohol	29·90	31·12	32·70	32·90	30·54	31·43
Water	6·74	6·25	6·50	6·01	5·98	6·30

The composition of ternary mixture of benzene, alcohol and water, determined similarly, is given in Table II.

Table III gives boiling range and other details of the binary and the ternary mixtures.

From Table I, it is seen that one pound of sample P_1 should withdraw 0·091 lb. of water, while sample P_2 should entrain 0·101 lb. of

cent. of the mixture contains on an average 89 per cent. petrol, 10·5 per cent. alcohol and 0·5 per cent. water (by volume). The top layer is returned to the still for forming fresh ternary mixture. Thus actually one pound of sample P_1 withdraws effectively 0·088 lb. of water and P_2, 0·096 lb. Similarly, one lb. of benzene effectively withdraws 0·091 lb. of water.

TABLE II

Benzene: Sp. gr. 0·883 at 15° C. Ref. Index N_D^{27} 1·497

	Case 1	2	3	4	5	
Benzene (grms.)	81·33	124·80	115·60	141·76	130·18	
Alcohol „	54·74	19·11	45·05	18·31	32·17	
Watar „	35·82	30·84	7·43	13·43	7·46	
Total ..	171·89	174·75	168·08	173·50	169·81	
Wt. of ternary mixture ..	112·30	106·70	105·60	106·20	107·79	
Composition per cent. by weight (Atm. pressure = 700 mm.)						Average
Benzene	75·2	74·73	75·23	74·20	75·24	74·92
Alcohol	17·1	17·91	17·21	18·90	17·84	17·77
Water	7·7	7·36	7·56	6·90	6·92	7·31

TABLE III

Sample	Binary Mixture	Boiling Range °C.	Ternary Mixture	Boiling Range °C.	Per cent. by Volume of top and bottom layers (Temp. 30° C.)
P_1	P_1. A.	68·5° to 70·5°	P_1. A. W.	66° to 68·5°	Top .. 56% Bot. .. 44%
P_1	P_1. W.	74° to 80°	..	..	..
P_2	P_2. A.	66·5° to 71°	P_2. A. W.	62·5° to 69·5°	Top .. 57% Bot. .. 43%
P_2	P_2. W.	72° to 85°	..	..	..
Benzene	B. A.	66·25°	B. A. W.	63·0°	Top .. 87% Bot. .. 13%
„	B. W.	67·5°	..	..	..

From Table III we notice that the binary mixture of P_2.A. is formed between 66·5° to 71°, whereas the ternary mixture of P_2.A.W. is formed between 62·5° to 69·5°. It will at once be apparent that the formation of binary mixture of P_2.A. in the range 66·5° to 69·5° will diminish the efficiency of petrol as an entrainer as some of the hydrocarbons of the petrol form binary mixture with alcohol and distil over along with the rest of the hydrocarbons forming the ternary mixture with alcohol and water. It is found from the refractive index values that about 18 per cent. of the petrol (P_2) has constituents which form the binary mixture in the range 66·5° to 69·5°. Thus, in the composition of ternary mixture this correction has to be allowed for, when, in fact, the efficiency of the sample would read much higher. In this particular instance, in spite of about 18 per cent. of the petrol (P_2) forming the binary mixture, the amount of water withdrawn is more than that of the sample P_1. But, in general, it may be mentioned that in the choice of entrainers, the formation of such binary mixtures interfering with the formation of ternary mixtures, is inadvisable,

because, besides being of no value in the dehydration of alcohol, they occupy unnecessary space in the still and they consume steam which is not profitably spent.

The lower layer of the ternary azeotropic distillate, which contains most of the entrained water, is treated in a separate still for the elimination of water and for the recovery of alcohol and benzene. With the petrol fractions, the lower layer forms about 43 to 44 per cent. while with benzene it is about 13 to 15 per cent. It must be mentioned that the smaller the volume of the lower layer, the greater the efficiency of the process.

N. SRINIVASAN.

Distillery, M.S.Co., Ltd.,
Mandya,
March 20, 1941.

[1] *Chimie and Industrie*, 1930 ; *I.S.J.*, 1930, p. 77.
[2] Sydney Young, *Distillation Principles and Processes*, pp. 177–180.
[3] *Ibid.*, p. 179.

AN IDEAL PRESERVATIVE FOR SUSPECTED WASHES

IN cases of seizure of suspected washes, the plea often put up by the accused is that the wash seized is not really a fermented wash and that the alcohol detected has been formed after seizure due to use of an ineffective antifermenting agent. It was therefore thought desirable to study carefully the antifermenting properties of various preservatives commonly used for this purpose. In the United Provinces, Bengal and Bihar, 25 grains of salicylic acid are generally added to every quart bottle of suspected wash to arrest further fermentation.

Experiments were first carried out (under conditions similar to those used in actual practice in Excise cases) to test the power of arresting further fermentation of partially fermented washes of the following preservatives:

(1) Salicylic acid. (2) Benzoic acid. (3) Formic acid. (4) Mercuric iodide in potassium iodide solution. (5) Ammonium fluoride.

The results of some of these experiments are given in Table A. The table shows that formic acid and ammonium fluoride are not suitable preservatives for checking further fermentation while salicylic acid, benzoic acid and mercuric iodide in potassium iodide are quite suitable for the purpose. Experiments were also done under varying conditions, *e.g.*, (i) in different seasons of the year, (ii) with mahua flowers as base, (iii) with addition of yeast food, but results similar to those given in Table A were obtained in every case.

In another series of experiments, 72 washes (still containing fermentable sugars) were re-examined 1 to 6 months (12 after 1 month; 12 after 2 months; 12 after 3 months; 12 after 4 months; 11 after 5 months and 13 after 6 months) after their receipt in this laboratory. The washes were of different strengths and had been received in connection with excise cases and contained sufficient quantity of salicylic acid (*i.e.*, 25 grains per quart or more). In none of these cases had the alcoholic strength increased appreciably, but in 5 of these cases the alcoholic strength had slightly diminished due to acetic fermentation. These results show that salicylic acid is quite a suitable preservative for arresting the further alcoholic fermentation of partially fermented washes received in excise cases.

We next directed our attention to the study of the action of the preservatives on unfermented sugar solutions. It had been noticed in this laboratory that when unfermented cane juice or gur solutions were left for some time without the addition of any yeast, appreciable amounts of alcohol were formed. Thus it was found in a set of 18 experiments that the alcoholic strength went up to 2 to 6% of proof spirit in 10 cases and to 6 to 13% of proof spirit in 5 cases. These differences in alcoholic strength are probably due to the differences in quantity and nature of yeast *naturally* present in the original cane juice and gur solutions. An ideal preservative should, therefore, not only prevent the further fermentation of partially fermented solutions but also of unfermented sugary solutions. Tables B and C show the course of fermentation of unfermented

TABLE A

Showing the percentage of proof spirit formed during a period of six months after the addition of peservatives to partially fermented Gur solutions

Concentration of Gur solution before fermentation	35%				25%					
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicylic acid	Benzoic acid	Mercuric iodide in KI	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	Ammonium fluoride	No preservative
Starting day ..	12·3	12·3	12·3	12·3	7·9	7·9	7·9	7·9	7·9	7·9
After 15 days ..	12·3	12·3	12·3	24·7 (Maximum)	7·9	7·9	7·9	7·9	7·9	10·2
,, 30 ,, ..	12·3	12·3	12·3		7·9	7·8	7·8	9·2	7·9	16·8 (Maximum)
,, 45 ,, ..	12·3	12·3	12·3		7·9	7·8	7·8	9·8	7·9	
,, 60 ,, ..	12·3	12·3	12·3		7·8	7·8	7·8	12·1	7·9	
,, 90 ,, ..	12·2	12·2	12·2		7·8	7·8	7·8	14·4	9·5	
,, 120 ,, ..	12·2	12·2	12·2		7·7	7·7	7·7	15·6	11·4	
,, 150 ,, ..	12·1	12·1	12·1		7·7	7·7	7·7	16·1	15·1	
,, 180 ,, ..	11·8	11·7	11·8		7·7	7·7	7·7	16·2	15·2	

Concentration of Gur solution before fermentation	15%					10%				
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative
Starting day ..	5·4	5·4	5·4	5·4	5·4	4·3	4·3	4·3	4·3	4·3
After 15 days ..	5·4	5·4	5·4	5·4	8·4	4·3	4·2	4·3	4·3	5·4
,, 30 ,, ..	5·4	5·4	5·4	5·5	9·9	4·3	4·2	4·3	5·5	6·2
,, 45 ,, ..	5·4	5·4	5·4	6·7	10·8 (Maximum)	4·3	4·2	4·3	5·9	7·9 (Maximum)
,, 60 ,, ..	5·4	5·4	5·4	7·5		4·3	4·2	4·3	6·2	
,, 90 ,, ..	5·4	5·4	5·4	9·0		4·2	4·2	4·2	7·7	
,, 120 ,, ..	5·3	5·3	5·4	9·4		4·1	4·1	4·2	7·5	
,, 150 ,, ..	5·3	5·3	5·4	9·7		4·1	4·1	4·2	7·5	
,, 180 ,,	5·3	5·3	5·4	9·6		4·1	4·1	4·1	7·5	

TABLE B

Showing the percentage of proof spirit formed during a period of six months after the addition of preservatives to unfermented sugar solutions

Nature and concentration of sugary solution taken	YEAST ADDED									
	25% Gur solution				25% Gur solution with another sample of Gur			15% Gur solution		
Preservative used 25 grains of the acid or the acid equivalent per quart bottle of 20 fl. ozs. capacity	Salicylic acid	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	12·2	12·3	Nil	12·4	13·5	Nil	10·7	Nil	Nil	9·2
,, 30 ,, ..	16·4	17·3	Nil	11·4	19·2	Nil	13·8	5·3	Nil	10·1
,, 45 ,, ..	16·4	17·6	Nil	7·5	19·6	Nil	14·6	9·4	Nil	9·4
,, 60 ,, ..	16·4	17·0	Nil	7·6	19·5	Nil	14·4	10·6	Nil	6·3
', 90 ,, ..	15·6	16·2	Nil	5·2	19·4	Nil	14·1	12·1	Nil	Highly acetic fermentation then developed
,, 120 ,, ..	15·6	16·2	Nil	4·8	19·3	Nil	14·1	12·1	Nil	
,, 150 ,, ..	15·4	16·1	Nil	4·5	19·1	Nil	8·4	12·1	Nil	
,, 180 ,, ..	14·7	15·2	Nil	3·9	18·3	Nil	7·8	11·9	Nil	

Nature and concentration of sugary solution taken	YEAST ADDED						WITHOUT ADDED YEAST					
	25% Mahua extract			25% Gur solution with another sample of Gur			25% Gur solution			25% Gur solution with another sample of Gur		
Preservative used 25 grains of the acid or the acid equivalent per quart bottle of 20 fl. ozs. capacity	Salicylic acid	Benzoic acid	No preservative	Sodium salicylate	Sodium benzoate	No preservative	Salicylic acid	Benzoic acid	No preservative	Salicylic acid	Benzoic acid	No preservative
Starting day	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days	0·1	Nil	15·4	8·3	Nil	5·4	2·0	Nil	5·4	0·5	Nil	17·5
,, 30 ,, ...	9·2	Nil	15·2	15·4	Nil	10·4	6·8	Nil	7·1	0·7	Nil	16·9
,, 45 ,, ...	15·3	Nil	15·2	15·9	Nil	11·6	15·7	Nil	7·9	0·5	Nil	16·2
,, 60 ,, ...	17·2	Nil	15·1	15·9	Nil	11·6	15·6	Nil	7·9	0·5	Nil	16·1
,, 90 ,, ...	17·5	Nil	15·1	15·9	Nil	11·8	15·5	Nil	9·1	0·5	Nil	16·1
,, 120 ,, ...	17·2	Nil	14·9	15·8	Nil	10·4	15·4	Nil	10·4	0·5	Nil	16·0
,, 150 ,, ...	17·1	Nil	14·8	15·8	Nil	7·1	15·2	Nil	13·1	3·5	Nil	15·9
,, 180 ,, ...	16·9	Nil	14·6	15·5	Nil	6·7	15·2	Nil	13·5	3·8	Nil	15·7

TABLE C

Showing the percentage of proof spirit formed during a period of six months after the addition of preservstives in unfermented Gur solutions to which yeast had been added

Concentration of Gur in the solution before fermentation started	25%					15%		
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Salicyclic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	Nil	Nil	Nil	Nil	2·0	Nil	Nil	Nil
,, 30 ,, ..	2·4	Nil	Nil	Nil	4·0	Nil	Nil	5·9
,, 45 ,, ..	13·4	Nil	15·9	9·7	7·9	Nil	Nil	12·0
,, 60 ,, ..	13·8	Nil	16·1	18·5	10·2	Nil	Nil	12·5
,, 90 ,, ..	13·6	Nil	16·1	18·4	16·8 (Maximum)	Nil	Nil	12·6
,, 120 ,, ..	12·3	Nil	15·2	18·2		1·9	Nil	11·9
,, 150 ,, ..	12·3	Nil	15·2	17·8		2·8	Nil	11·9
,, 180 ,, ..	11·8	Nil	15·2	17·7		3·2	Nil	11·8

Concentration of Gur solution before fermentation started	15%		10%				
Preservative used (25 grains per quart bottle of 20 fl. ozs. capacity)	Formic acid	No preservative	Salicylic acid	Benzoic acid	Mercuric iodide in KI	Formic acid	No preservative
Starting day ..	Nil	Nil	Nil	Nil	Nil	Nil	Nil
After 15 days ..	Nil	1·5	Nil	Nil	Nil	Nil	1·0
,, 30 ,, ..	Nil	2·8	Nil	Nil	Nil	Nil	1·4
,, 45 ,, ..	0·5	5·4	Nil	Nil	Nil	0·4	3·1
,, 60 ,, ..	0·5	8·4	Nil	Nil	Nil	0·4	4·3
,, 90 ,, ..	0·5	9·9	Nil	Nil	Nil	0·4	5·4
,, 120 ,, ..	0·3	10·8 (Maximum)	Nil	Nil	Nil	0·4	6·2
,, 150 ,, ..	0·3		0·2	Nil	0·1	0·7	7·9 (Maximum)
,, 180 ,, ..	0·3		0·5	Nil	1·0	2·2	

sugary solutions (*with and without addition of yeast*) to which various preservatives had been added. It would be seen from these tables that benzoic acid alone prevents the fermentation

of unfermented sugar solutions and that salicylic acid is not a suitable preservative for this purpose. Benzoic acid (25 grains per quart) should therefore be used in place of salicylic acid for arresting further fermentation of suspected washes seized in connection with excise cases. When salicylic acid is used as a preservative, there is a possibility of miscarriage of justice in cases where unfermented sugary solutions are seized, for salicylic acid does not check the fermentation of unfermented sugary solutions containing active yeasts.

Finally, experiments were made to see whether smaller quantities of benzoic acid would check further fermentation of washes. It was found that even 15 grains of benzoic acid per quart effectively stop the fermentation of unfermented sugary solutions (and also completely check the further fermentation of partially fermented washes) for a period of 6 months.

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Chemical Examiner's Laboratory,
Agra,
March 23, 1941.

A NEW HOST—*RICINUS COMMUNIS*—FOR *LÉVEILLULA TAURICA* (LÉV.) ARN. [*OIDIOPSIS TAURICA* (LÉV.) SALM.]

During recent years the castor crop on the Central Agricultural Research Station, Coimbatore has been subjected to infection by an endophytic powdery mildew. The disease is prevalent in the months of November–March. The mildewy growth is mainly confined to the lower surface of the leaves (Fig. 1). In advanced stages of heavy infection white growths are present on the upper surface also in some places. Corresponding to the mildew areas on the lower surface, light green patches can be seen from the upper side especially when the leaves are held against light. The disease is absent on the youngest leaves at the ends of branches.

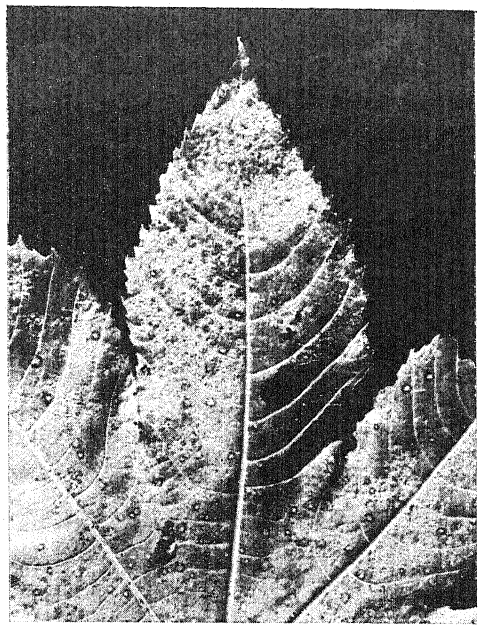

Fig. 1

Portion of a castor leaf (lower surface) showing powdery mildew.

The hyphæ are intercellular and occupy the spongy parenchyma of the mesophyll. Haustoria are produced and these penetrate into some of the parenchymatous cells. Conidiophores come out through the stoma in varying numbers. Branches develop from many of the conidiophores. Each branch produces one conidium at the tip. The conidia are hyaline and vary in shape, some having a tapering apex and others broad ends. Most of the conidia have a minute papilla-like projection at the broad end (Fig. 2*b*). They germinate readily in water producing a germ tube from one end and rarely from both ends (Fig. 2*c*). The spores measure on an average $67{\cdot}3 \times 18{\cdot}7\mu$. The ranges and their frequencies of the length and width of 200 conidia are given in the accompanying table.

The measurements and the distribution of the range agree with those of *Oidiopsis taurica*.

O. taurica has been observed on *Cyamopsis tetragonoloba*, *Capsicum annuum*, *Medicago sativa*, and *Vinca pusilla* from South India. *O. taurica* var. *macrospora* is present on *Dolichos*

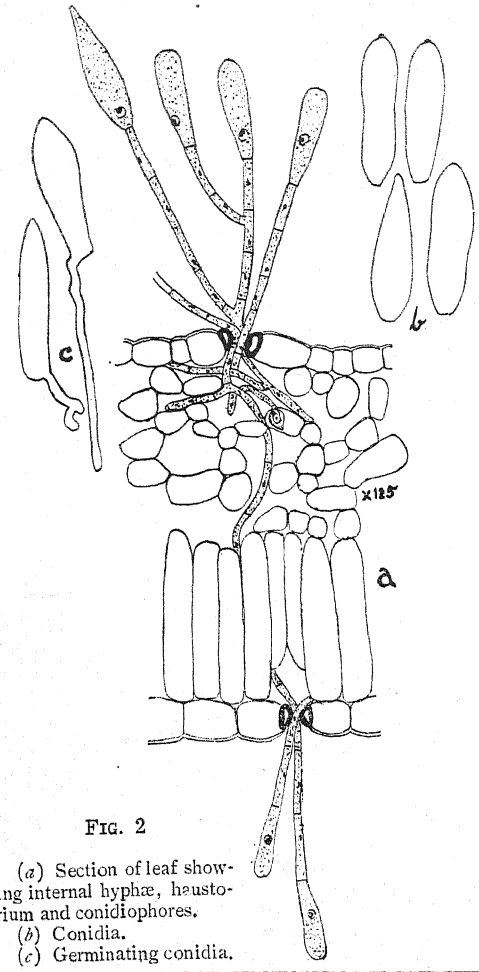

FIG. 2

(*a*) Section of leaf showing internal hyphæ, haustorium and conidiophores.
(*b*) Conidia.
(*c*) Germinating conidia.

Length		Width	
Class in μ	Frequency	Class in μ	Frequency
52·1—56	3	12—14·9	4
56·1—60	10	15—17·9	91
60·1—64	24	18—20·9	82
64·1—68	68	21—23·9	23
68·1—72	48		
72·1—76	39		
76·1—80	5		
80·1—84	2		
84·1—88	1		

lablab. But this is the first record of the fungus on castor.

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March 3, 1941.

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PYTHIUM APHANIDERMATUM (EDSON) FITZ. ON *CARICA PAPAYA*

EDSON[1] in 1915 described *Pythium aphanidermatum* as the cause of damping off of seedlings of sugar beets (*Beta vulgaris* L.) and radish (*Raphanus sativus* L.) in Wisconsin, U.S.A. Since then it has been reported on a variety of hosts from various parts of the world.

Vaughan[2] and Gardner[3] report a black rot of radish due to this species in Indiana, while Bunting[4] attributes to it the "damping off" of tobacco in Africa. Drechsler[5] describes a cottony leak of cucumbers (*Cucumis sativus* L.) caused by this fungus. He[6] also found it to be the causal agent of a cottony leak of *Solanum melongena* in Florida. In Sumatra Jochems[7] isolated it from Deli Tobacco. Tempany[8] mentions it causing a collar disease of tomato in Malay. Recently Tasugi and Takatuzi[9] report *Nematosporangium* (*Pythium*) *aphanidermatum* on *Phaseolus vulgaris* from Japan. Massey[10] describes this species attacking cotton in Sudan and Van Eek[11] on Pansy in Holland.

In India Subramaniam[12] ascribed a Pythium disease of ginger (*Zingiber officinale* Roscoe), Tobacco (*Nicotiana tabacum* L.) and Papaya (*Carica Papaya* L.) to *Pythium Butleri*. Due to its great similarity with *P. aphanidermatum* Carpenter,[13] Fitzpatrick[14] and Matthews[15] consider *P. Butleri* synonymous with *P. aphanidermatum*. Drechsler[16] makes a differentiation between *P. Butleri* and *P. aphanidermatum* on

grounds of dimensions and reproductive behaviour. Later on Mitra,[17] Sundararaman,[18] Ramakrishna Ayyar[19] and McRae[20] reported its isolation from various species of Cucurbitaceæ (*Opuntia dilleini*) and chilli (*Capsicum annuum* L.). Recently it was seen to cause a malodorous rot of water melon by Kheswalla[21] and a wet rot of tobacco seedling by Venkatarayan.[22] Galloway[23] mentions it on hemp.

Last year during the rainy season some "stem and foot rot" of Papaya trees (*Carica papaya*) was observed in an epidemic form in the Agricultural Institute Farm, Naini (Allahabad). Dr. E. F. Vestal, Ph.D., Plant Pathologist of the Institute, isolated the fungus from the diseased stem by the usual method and kindly gave it to me for identification. Inoculations made by Dr. Vestal on healthy trees were partly successful. The patches caused by the fungus heal up in winter and inoculations made in the months of November and December did not show any sign of disease probably due to low temperature and dry weather. After studying the life-history the fungus was found to be *Pythium aphanidermatum* (Eds.) Fitz.

In artificial media the mycelium is well developed on corn-meal agar, bacto-peptone agar, bean agar and oat-meal agar. The hyphæ are aseptate, hyaline and with granular contents; irregularly and abundantly branched, varying in breadth from 2–5·8μ in diameter. Sporangia are formed in abundance when small tufts of aerial mycelium are cultivated for 4 to 5 days at 25° C. in a solution recommended by Petri.[24] They are filamentous composed of a lobulate inflated mass of branches with a long or short tube of discharge. They have also been observed on a solid medium (Bean agar). Number of zoospores varies from 4 to 30 in each sporangium. They are biciliate and bean-shaped. Oogonia are formed in abundance on oat-meal agar at 20° C. They are smooth, terminal, spherical and measure 18·9 to 28μ in diameter. Antheridia are single (rarely 2 to an oogonium) mostly intercalary, also stalked and terminal. Both hypogynal and diclinous conditions are to be found. Sometimes antheridia have a pointed beak. The cospores are smooth, round, thick-walled, not filling the oogonium, varying from 10·8 to 19·5μ in diameter.

Further work on the preventive methods of the disease is in progress.

The writer is indebted to Dr. R. K. Saksena for his valuable suggestions and guidance and his thanks are also due to Dr. E. F. Vestal for supplying the material.

K. S. Bhargava.

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University of Allahabad,
Allahabad,
February 15, 1941.

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ECONOMICS OF MANURING

By P. V. SUKHATME, PH.D., D.Sc., *Imperial Council of Agricultural Research*

IN a recent article[1] in the *Indian Farming*, Dr. W. Burns has raised two important questions regarding economic aspects of manuring, namely: 'Does manuring pay?' meaning thereby 'Does the money value of the additional crop exceed the price paid for the manure applied?', and 'what is the amount of manure that it would pay to apply?', given certain prices for manure and for produce. Dr. Burns has further stated that it would be advisable if the economic aspect of manuring crops was discussed with a precision that can be expressed in a table or a graph. The following method would appear to supply precise answers to the questions raised by Dr. Burns:

The appropriate statistical test to answer the first of the two questions is obviously the test of significance for profit which is the excess of the value of additional produce over the value of manure applied including the incidental charges of application, etc. For a given price of produce, the value of yield per plot is subject to the same experimental errors as the quantity of yield itself, so that if p is the price of produce per unit weight and u the error variance of yield per plot, the error variance of value per plot will be merely p^2u. The error variance of the mean value will be $\frac{p^2u}{r}$, r being the number of replications and that of the difference in mean values of manured over non-manured plots and hence that of the profit for a given price of manure will be $\frac{2p^2u}{r}$. The test of significance of profit is simply given by the quotient t of the profit by its standard error distributed in Fisher's well-known t distribution. If t is sufficiently large giving a large probability that profit as large or larger than the one observed would occur in future, it would indicate that manuring may be expected to pay for its cost. The whole validity of the approach follows by regarding the monetary value of yield rather than quantity as the measurable produce for manurial experiments. It is apparent that following the above approach a table or a graph or both can be readily constructed showing if it would pay to manure a crop at given prices for produce and for manure.

[1] W. Burns, *Indian Farming*, 1940, **1**, 365.

The precise determination of the optimum dose of manuring presupposes a known form of relationship between the value of extra produce and the dose of manure applied. Field experiments rarely include more than three to four doses of manuring, which are obviously too few to provide an adequate indication of this relationship. It appears, however, reasonable to assume that a second-degree parabola of the form $v = \alpha + \beta d + \gamma d^2$ with $\gamma - ve$, where v denotes value and d the dose of manure, would adequately represent the relation. It is a curve fairly extensively used to represent the relation in question and is clearly the one that common sense and facts support. The equation to the straight line giving the cost of manure is clearly $v = qd$, where q is the price per unit dose of manure. It will now be readily seen that the optimum dose is given by the point where the tangent to the value curve is parallel to the cost line for manure. In the notation used above the optimum dose d is given by $\frac{q-\beta}{2\gamma}$.

The standard-error of the optimum dose is readily derived. The value-curve can be alternatively written in the form

$$v = \bar{v} + b_1 \xi_1 + b_2 \xi_2$$

where $\bar{v}$ is the average of observed values, ξ_1 and ξ_2 are the orthogonal functions of d given by

$$\xi_1 = d - \bar{d} \text{ and } \xi_2 = \xi_1^2 - \frac{n'^2 - 1}{12}$$

and b_1 and b_2 are constants whose values are determined by the usual method of fitting a multiple regression equation. The sampling errors of b_1 and b_2 being clearly independent, the variance of the optimum dose is simply given by the variance of $\frac{q - b_1}{2b_2}$ which appears to be

$$\sigma^2 \left\{ \frac{(\hat{d} - \bar{d})^2}{S(\xi_2^2)} + \frac{1}{4} \cdot \frac{1}{S(\xi_1^2)} \right\}.$$

The profit to be expected for any given dose of manure is clearly given by the ordinate of the value curve. It follows from what has been given above that its variance is simply the variance of $\bar{v}$ plus the quantity

$$\sigma^2 \left\{ \frac{\xi_1^2}{S(\xi_1^2)} + \frac{\xi_2^2}{S(\xi_2^2)} \right\}.$$

The method outlined above has been illustrated in detail in an article to be published in the *Indian Journal of Agricultural Science*.

PURIFICATION AND CHEMICAL NATURE OF RENNIN

BY

C. N. BHIMA RAO, M. V. LAKSHMINARAYAN RAO, M. S. RAMASWAMY AND V. SUBRAHMANYAN

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IN recent years, a number of attempts have been made to prepare integrally pure rennin and to establish its chemical nature. Among these, special mention should be made of the work of Fenger,[1] who obtained a preparation which was nearly free from pepsin and contained 14·0 per cent. nitrogen and 0·7 per cent. phosphorus; Lüers and Bader[2] whose product was over seven times as active as that of Fenger, but showed distinct peptic activity and contained only 0·68 per cent. nitrogen; Tauber and Kleiner[3] whose best preparation contained no pepsin and gave the following percentage composition: carbon, 61·3; hydrogen, 7·02; nitrogen, 14·4; phosphorus, nil; chlorine, nil; sulphur, 1·19; and ash, 0·4. The last authors admit the possibility of their preparation containing an impurity of high nitrogen content but conclude, tentatively, that the enzyme is a thioproteose.

The present enquiry was undertaken with the object of throwing some light on the nitrogen status of the enzyme and to obtain some fresh evidence regarding its chemical nature.

The procedure adopted by us for the initial purification of the enzyme from calf stomach mucosa is based on the following findings:—

(1) On allowing ground mucosa to stand with 0·04 N HCl for 18 to 24 hours, an active extract is obtained which can be dialysed overnight without any appreciable loss of activity. During this dialysis, there is the separation of mucilaginous precipitate which carries down the major part of the enzyme. From this precipitate, the enzyme can be easily extracted in a concentrated form. The following is an example:

Acid extract of mucosa (obtained after standing for 24 hours. 50 ml. : 4 units* per ml.)
↓ dialysed overnight against water and then centrifuged
Precipitate — Supernatant (14 units*)
↓ extracted with 5 ml. of 0·04 N HCl and centrifuged
Precipitate (*Ca* 4 units*) — Supernatant (188 units* 37·6 units* per ml.)

By using more dilute acid than the above, the enzyme can be extracted out of the mucilage in a number of small fractions of varying degrees of purity.

(2) On adjusting the acid extracts as obtained in (1) to pH 5·4 (when a fine precipitate forms) and centrifuging the resulting suspensions, clear supernatants at higher levels of purity (as determined by the ratio of nitrogen to activity) than the starting materials can be obtained. The following is an example:

* The unit of enzyme as adopted by us may be defined as that required to clot 10 ml. of a 30 per cent. solution of 'Klim' whole milk powder in 0·3 M acetate buffer of pH 4·6 in one minute at 37°. This unit is roughly 15 times and in some cases 30 times, that adopted by earlier workers and was necessitated by the high activity of our preparations and the need for obtaining quick, reproducible and sharp clots. Where comparisions with earlier observations are necessary, the results have all been computed on the same basis.

Extract of mucosa (24 hr. old
3 units per ml. : total Ca 1600 units)
dialysed overnight and centrifuged

Precipitate (1300 units) | Supernatant (1·4 units per ml. (rejected) 424 μg. of N per unit)

washed twice with water on the centrifuge

Precipitate | Supernatant (2 units per ml.: 15 ml. (rejected) 183·4 μg. of N per unit)

extracted with 75 ml. of 0·01 N HCl and centrifuged

Precipitate (mostly insoluble, 70 units. Rejected) | Supernatant (6·6 units per ml. 19 μg. of N per unit)

adjusted to pH 5·4 with saturated Na_2HPO_4 and then centrifuged

Precipitate | Supernatant (70 ml. : 1·4 units per ml. 23·5 μg. of N per unit) Rejected

Extracted with 0·02 N HCl and centrifuged

Precipitate (small and inactive) Rejected | Supernatant

adjusted to pH 5·4 and centrifuged

Precipitate | Supernatant (43 ml. : 3 units per ml. 7 μg. of N per unit)

Extracted with 0·02 N HCl, adjusted to pH 5·4 and centrifuged

Fractionation continued in the above manner until a level of 2–3 μg. per unit was attained.

The next step in the purification was based on the observation that the mucilage (obtained on dialysis) can be repeatedly extracted with acid and reprecipitated at pH 5·4 until it is free from enzyme. It can then be used for adsorbing the enzyme, preferentially, from the associated nitrogenous impurities. Example:

Enzyme (100 ml. : 12 μg. of N per unit
+ 2 units per ml.)
Mucilage (enzyme-free)

allowed to stand overnight against water in cellophane bag, then dialysed against running water for 2 hrs. followed by centrifuging

Precipitate | Supernatant (Inactive)

extracted with 0·04 N HCl, adjusted to pH 5·4 and centrifuged

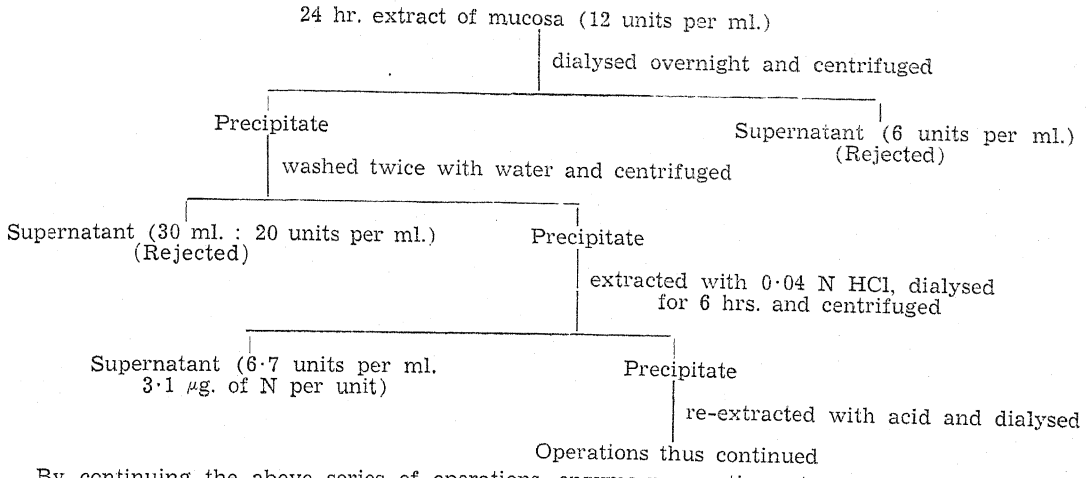
Supernatant (4 units per ml. 1·0 μg. of N per unit) | Precipitate

extracted with acid and reprecipitated at pH 5·4

Operations thus continued

By extending the above operations, fractions containing even less than 1 μg. of N per unit were obtained, but the yields in such cases were generally small, totalling only 5 to 10 units in each case.

Considerable amount of purification can be effected by merely following a process of successive acid extraction followed by dialysis. Example:



By continuing the above series of operations, enzyme preparations at as low a level as 1·4 μg. of N per unit have been obtained.

It may be mentioned, however, that the above procedure is slow and tedious. It involves considerable wastage of enzyme. It is not therefore recommended except for certain types of preparatory work wherein phosphate-free enzyme is required.

Properties of the enzyme at 1·0 μg. *(per unit of N) level.*—The enzyme at this level gives a water clear solution which does not form a precipitate either on heating or on addition of trichloracetic acid. On drying, it gives a pale yellow solid corresponding 30 μg. per unit. Calculated on the same basis of activity, this would be approximately 9 to 10 times as pure as Tauber's in regard to nitrogen and nearly twice as pure in regard to dry weight.

There is a peculiar feature in regard to the ratio of dry weight to nitrogen. Even assuming that the nitrogen formed a part of the enzyme, there is a strong suggestion that the preparation contains a non-nitrogenous impurity. This can be confirmed both after short period dialysis and on allowing the preparation to stand for some time, when some of the non-nitrogenous impurity is deposited without appreciably altering the activity of the preparation.

The preparation does not respond to most protein tests, while, in a few cases, the colouration is faintly positive.

Tests for sulphur, pepsin and carbonic anhydrase were negative.

The preparation keeps tolerably well when maintained out of contact with air and in the cold. At the ordinary temperature (25 to 35°), the activity is rapidly lost. At this level of purity the enzyme does not lend itself to concentration by the usual freezing and desiccation methods. The major part of the enzyme is lost during concentration. The preparation can be dialysed against water for a short period without appreciable loss of activity.

Relation of nitrogen to enzyme.—There was considerable amount of indirect evidence to suggest that the nitrogen associated with the enzyme at different stages was an impurity:

(1) When the mucilage containing the enzyme was extracted with successive portions of dilute acid of the same strength (*e.g.*, 0·01 N HCl) and centrifuged after adjusting to pH 5·4, the quantities of nitrogen present in the different extracts were more or less the same and practically independent of the amount of enzyme (as shown by activity) present in each fraction.

(2) On mixing the enzyme at a high level of purity (1–2 μg. of N per unit) with a small amount of enzyme-free mucilage and centrifuging the suspension, all the nitrogen was left in the supernatant, while practically all the activity passed into the precipitate. This could not have occurred if the nitrogen were a part of the enzyme molecule.

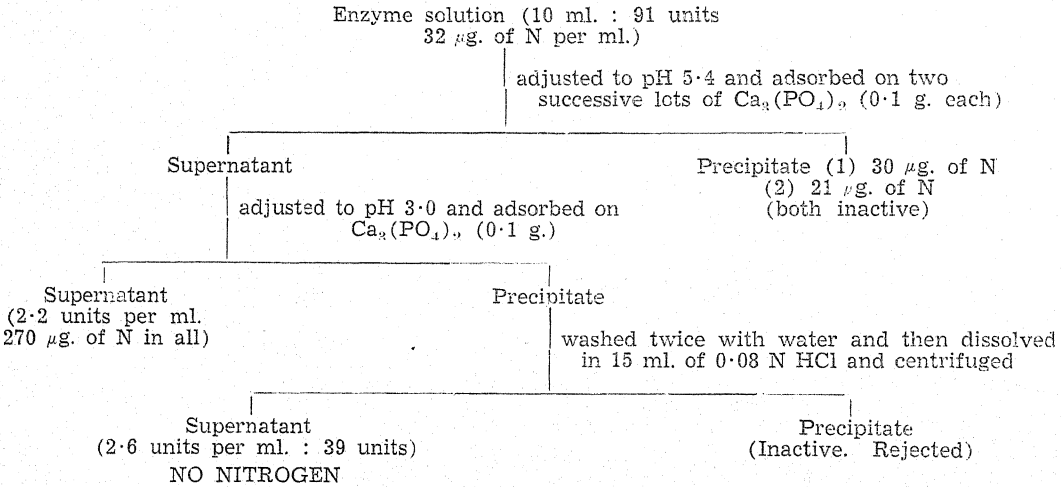
(3) Filter aids (*e.g.*, Celite 501) adsorbed practically the whole of the enzyme leaving the nitrogen in the supernatant.

(4) Alumina C_γ adsorbed the enzyme

preferentially (25 : 1 when mixed with a preparation at 12·5 μg. of N per unit level) leaving the major part of nitrogen in the supernatant. Adsorption on kaolin also gave a similar result.

In none of the above cases was it possible to elute the enzyme successfully. Thus, the muco-protein of the mucilage always tended to dissolve to some extent (1·5 — 5·0 μg. of N per ml. depending on concentration of reagents) when extracted with dilute acid and precipitated at pH 5·4; the enzyme could not be eluted from celite and kaolin; phosphate buffer (pH 7·0 to 7·2—a more alkaline buffer could not be used because of its adverse effect on the enzyme) eluted the nitrogen preferentially from alumina C_γ leaving the major part of the enzyme in an unextractable condition.

Tricalcium phosphate proved a more promising material. It adsorbed both the enzyme and nitrogen, when used as aqueous suspension, but showed considerable preference for the enzyme when used in the partially dried, solid condition (the reason for this is still not clear). Elution with buffers proved inefficient, so the entire adsorbate was dissolved in acid with satisfactory results. Example:



The determinations of nitrogen were ordinarily carried out by a micro-kjeldahl method followed by titration, but in cases like the above, each figure was checked, in replicate, by colorimetric estimation, the values being correct to 0·1 μg. The results show conclusively that the adsorbate obtained at pH 3·0 contained enzyme which was completely free from nitrogen.

The above observations have since been repeated a number of times and on a large scale. An essential condition for success seems to be the presence of an electrolyte (*e.g.*, phosphate in the present case) which apparently checks the adsorption of nitrogen by the tricalcium phosphate.

There has been some difficulty in estimating the true dry weight of the nitrogen-free enzyme. This is partly due to the difficulty in removing the last traces of tricalcium phosphate. Indirect evidence already obtained would suggest that the true dry weight is less than 10 μg. per unit.

The enzyme at the highest level of purity is extremely labile. The activity drops by about 75 per cent. in the course of a day. Experiments on the stabilisation of the pure enzyme and the study of its various properties and kinetics of reaction are in progress.

Reversible inactivation of rennin and the evidence for the existence of a thermostable component in the enzyme.—Extensive series of experiments were carried out on this aspect of the problem and the more important findings may be summarised as follows:

(1) Although rennin is rapidly and irreversibly inactivated at pH 8·0 and above, it does, nevertheless, undergo a slow and reversible type of inactivation in the region of pH 7·0 to 7·4. The latter type of inactivation can be arrested by adding sufficient acid to adjust the reaction to pH 2·0.

(2) On adding a small portion of boiled enzyme or autolysate of mucosa to partially inactivated enzyme as obtained in (1), a

considerable part of the original activity is restored. This would suggest the presence of a thermostable component in the enzyme.

(3) A number of known substances were examined with a view to determining whether any of them can replace the thermostable component, but, so far, only zinc salts have been found to possess that property.

The following results will illustrate the above:

	Substrates 20% milk	30% milk
1. Partially inactivated enzyme alone	4′ 30″	6′ 20″
,, + boiled enzyme	2′ 40″	4′ 15″

Original enzyme clotted in 1′ 20″. Boiled enzyme alone had no clotting effect.

	30% milk
2. Partially inactivated enzyme alone	7′ 30″
,, ,, + autolysate from mucosa (boiled)	2′ 35″

Original enzyme clotted in 1′ 30″. The autolysate (boiled) had no clotting effect.

	30% milk
3. Partially inactivated enzyme alone	6′ 30″
,, + $CaCl_2$ (1 drop 1%)	> 7′
,, + $CdSO_4$,,	> 7′
,, + $MgSO_4$,,	> 7′
,, + $SnCl_2$,,	> 7′
,, + $ZnCl_2$,,	2′ 30″

Original enzyme clotted in 1′ 20″. None of the salts (at the concentration used) had any direct effect on the milk. It may be further added that contrary to the report of Andreitchewa,[4] zinc at the concentration used has no effect on fresh rennin (before inactivation) and that the restoration is observed only in the case of the partially inactivated enzyme.

The above and similar experiments (which were repeated dozens of times) were carried out under identical conditions and with the necessary controls. These will be described in a detailed paper.

Some of the properties of the thermostable component.—It is stable in moderately acid or alkaline media; withstands prolonged boiling but is fairly rapidly lost on dialysis; present in the enzyme preparations at all levels of purity so far tested; mostly lost or otherwise transformed during prolonged evaporation, aeration or distillation under reduced pressure; inhibited in its action by sodium chloride and other salts in high concentration. It behaves generally like a co-enzyme.

Possible relation of ascorbic acid (vitamin C) to rennin.—Some of the properties of the enzyme, *e.g.*, instability in alkaline media, and sensitiveness to air and mild oxidising agents (*e.g.*, iodine), suggested some resemblance to ascorbic acid, hence attempts were made to determine whether it contained any of that vitamin. This was, in fact, found to be the case, the vitamin being present exclusively in some combined condition in all the preparations (including the nitrogen-free enzyme) in the proportion of about 0·10 μg. per unit.

It is not yet possible to state whether the vitamin is present as a part of the enzyme molecule or is associated with an impurity, still present in the final stages, but in view of its possibly great practical importance, the above observation is now being carefully followed up.

Chemical nature of rennin.—The foregoing observations suggest that rennin is probably a less complex substance than has hitherto been assumed. The absence of nitrogen, sulphur or phosphorus greatly restricts the scope of the enquiry. The purest enzyme is now being prepared on a sufficiently large scale to facilitate the study of its elementary chemical composition, which is probably made up of only carbon, hydrogen, oxygen together with some mineral constituents. The properties and behaviour of the thermostable component would suggest that it is something very similar, if not, identical with zinc. (Zinc has already been found at various levels of purity, though the quantitative data require confirmation). If the presence of combined ascorbic acid is conclusively established, it would point to a definite rôle for that vitamin not only in rennin but also in other similar enzyme systems.

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[1] Fenger, F., *J.A.C.S*, 1923, **45**, 249.

[2] Lüers, H., and Bader, J., *Biochem. Zeit.*, 1927, **190**, 122.

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[4] Andreitchewa, M., *Bull. Soc. Chim. Biol.*, 1930, **12**, 44.

REVIEWS

Anti-Mosquito Measures with Special Reference to India. Fifth Edition. By Lt.-Col. G. Covell, I.M.S. *Health Bulletin No.* 11, Malaria Bureau No. 3. (Manager of Publications, Delhi), 1940. Pp. 56. Price As. 8 or 9*d*.

This small bulletin deals in a concise but useful manner with the essential features of the modern methods of mosquito control. When it is realized that mosquitoes and the diseases transmitted by them can be controlled by more than one method, it becomes evident that the choice of method in any particular situation needs careful consideration. It is not possible, within the compass of this small bulletin of fifty-six pages, to go in detail into the intricate technicalities of the different aspects of mosquito control. But it is possible first to describe briefly most of the well-tried and accepted methods and then to indicate briefly under each method its merits and limitations. The author has very successfully done this, and consequently the bulletin presents a balanced description of the several methods of mosquito control now in use. Some of the latest developments, such as spray-killing adult mosquitoes, dustless method of applying paris green, etc., are included as also a fine chapter on naturalistic methods.

T. R. R.

Farm Animals, Their Breeding, Growth, and Inheritance. By John Hammond. (Messrs. Edward Arnold & Co., London), 1940. Pp. viii + 199. Price 14*sh*.

The book *Farm Animals* by John Hammond, which is based on two lectures given by him contains a brief sketch of the latest advances in the study of the scientific principles governing the genesis, growth and reproduction of farm animals, such as horses, cattle, sheep, pigs and poultry. The book is divided into two parts. The first deals with the principles of utility and growth of live-stock and poultry and the second, with those relating to genetics. In a small book of this kind it is only natural that the subject is dealt with in a very brief manner, only touching upon the latest advances in the science of genetics.

Under Part I, breeding seasons of the different animals, their fertility and sterility and artificial insemination are dealt with briefly and under Part II, the principles of heredity, the effects of selection and environment and other special problems in breeding for commercial utility are briefly outlined. The book is very well illustrated, but what is more important, it contains at the end a list of references which would be very valuable for collecting more detailed information on the subjects referred to in the book.

B. T. N.

Insect Pests in Stored Products. By H. Hayhurst. (Chapman and Hall, Ltd., London), 1940. Pp. 83 + 48 plates. Price 5*sh*. net.

This publication is in the nature of a handbook of 83 pages with numerous photographs of insects that infest stored products, brief notes on them and a list of substances and their pests for ready reference. In describing the insects, the orders are first referred to, then the families; the individual insects are then described. The book is written for the benefit of laymen, millers and store keepers. The treatment is not rigorously scientific. Entomological notes are rather loosely given and some of the technical conventions observed in entomological publications are overlooked. Thus the names of the insects are not authenticated by including the authors' names except in the case of those insects which are illustrated in the book.

In the list of substances and pests at the end of the book we find the following under substances: *Ephestia* (a moth), *Mites,* Plodia (a moth), *Tyroglyphidæ* (mites); and the following under pests: *Microbracon, Lyctocoris, Chelifer*!!

As a handbook for millers and store keepers, the book may prove useful. One would have wished for a more satisfactory treatment of the subject both with regard to the insect pests and the methods of pest control.

T. V. S.

ANNALS OF PHYSICS: RECORD OF A YEAR'S ACHIEVEMENTS

Reports on Progress in Physics, Vol. VI, 1939. Edited by J. H. Awbery. (Published by the Physical Society, London), 1940. Pp. vi + 434. Price to non-Fellows 22*sh.* 6*d.* net.

WHEN one surveys the enormous output of scientific literature bearing on even circumscribed fields of knowledge, one is appalled at the task of sifting all this and choosing what one absolutely needs if one is to play an intelligent part in life. Even a devoted worker in a given field must find some time to discover how some advance in another field affects the prospects of success in his chosen subject. He cannot generally wait till an authoritative account appears in the form of a book, or, even if he waits, the particular detail that would be useful to him may not be found in the book. Thus arises the problem of providing periodical surveys of recent progress so as to serve the needs of one who has not specialised in the particular field surveyed. This problem has been tackled in a variety of ways and each solution has its own usefulness. In the first place, we have the abstracting Journals such as, for Physics, *Science Abstracts,* Section A, *Physikalische Berichte, Journal de Physique,* Section D, etc. If possible, one should consult these and make a list of the references bearing on the problem in hand. However, this procedure is not always possible to pursue. Then one can consult such articles as appear in *Die Physik* where a summary of all the literature bearing on selected topics is given. When one lacks either the time or the knowledge requisite to make one's own list of references, one has to turn to an account by an expert such as one finds in the articles in *The Reviews of Modern Physics* or the *Physikalische Zeitschrift.* When an account is needed which will serve the non-specialist reader, one should turn to the articles appearing in such Journals as *Science Progress, Nature, Die Naturwissenschaften, The Journal of Applied Physics* and so on. On the other hand, when one desires to have an idea of the outstanding achievements in a given year, one now naturally turns to the *Reports on Progress in Physics* brought out by the Physical Society of London. These Reports have now established a place for themselves in a Physicist's Library and the present book, *viz.*, Vol. VI of these Reports fully satisfies the expectations that one has formed from a knowledge of the previous volumes of the series. In a way the articles in the Report partake of some features characteristic of the various Journals we have mentioned above. Thus we find a similarity to *Science Progress* in some articles which deal with all the work done in a given field such as those on 'Sound' by E. G. Richardson, and 'Heat' by R. W. Powell. The article by Richardson is indeed a model of what such a survey should be. There are articles on specialised topics like "Induced Radioactivity" by the late H. J. Walke, "Separation of Isotopes" by H. C. Urey and "The Meson" by Peierls, which are reminiscent of *The Reviews of Modern Physics.* Some articles on applied physics like "Fluid Motion" by A. Fage, "Kinetic Theory of the Elasticity of Rubber" by H. Pelzer, "X-Rays and Crystals" by J. M. Robertson, W. H. Taylor, H. Lipson and E. T. Goodwin, remind one of the *Journal of Applied Physics.* The bibliography at the end of the articles reminds one of *Die Physik.* Many of the articles can certainly be followed by non-specialists, but, though the whole book is meant for such readers, it is doubtful if one can make good use of some articles like those on "The Physics of Stellar Interiors and Stellar Evolution" by H. A. Bethe and R. E. Marshak, "The Theory of Molecular Structure" by W. G. Penney, or "The Magnetic Effect in Diatomic Spectra" by M. H. Crawford, without a rather good knowledge of the subject to start with. Many of the contributors are certainly masters in their several fields and their articles carry the authoritativeness we should expect from them, but it is not always that we find that simplicity, freshness and attractiveness which is characteristic of some articles in such Journals as the *Bell System Technical Journal* or *The Journal of the Franklin Institute* or *Die Naturwissenschaften.* The Editor says that "the proportion of matters of topical interest has gradually been growing as experience and criticism have shown what was most needed", but from the point of view of a teacher of physics, we should welcome more surveys like that of E. G. Richardson,

describing most of what has been done and at the same time giving a critical valuation of the work described. In another way, we should like to see more articles resembling those of Darrow in *The Bell System Technical Journal*, in order that the needs of a non-specialist may be more effectively met. The get-up of the book is excellent: in fact we have noticed only two misprints in the entire volume. The Physical Society is to be congratulated on publishing such a fine volume, fully up to the standards set by previous volumes, even under the stress and turmoil of a war that threatens the very foundations of civilisation. We hope that the success of the present book may be such that the Society will be able to present an even better volume for 1940. It is superfluous to add that no Physics Library should be without its copy.

T. S. SUBBARAYA.

THE OUTLOOK FOR WHALE OIL AND WHALING

Whale Oil: An Economic Analysis. By Karl Brandt. *Fats and Oils Studies*, No. 7. (Food Research Institute, Stanford University, California), June 1940. Pp. xii + 264. Price $3·00.

THE application of the process of oil hardening by hydrogenation about 1907 and the consequent increase in the industrial utility of whale oil led to the phenomenal expansion of whaling which reached its culminating point in 1931 when over 42,000 whales were taken and some 614,500 tons of oil produced. A large amount of this production remained unsold for a time; the surplus weighed on the market and contributed to the slump in oils and fats which reached its nadir in 1934. It became, indeed, usual for producers of vegetable oils and oilseeds to regard whale oil as the main cause of their economic difficulties, and moreover an interloper in the market.

Far from being a newcomer, whaling has of course a long and eventful history, which forms one of the most fascinating chapters of the story of world commerce. The work under review gives a good account of this history back to that ninth century Norwegian Othar, whose whaling narratives were recorded by Alfred the Great.

From about 1600 to 1859 Arctic whaling was pursued by several nations, in particular the Dutch, the British and the German Hansa ports, chief of which was Hamburg. The nineteenth century saw the peak of the prosperity of the famous American whaling industry in the 1850's. The products of these industries were whalebone, sperm oil and spermaceti, and whale oil. Sperm oil as a lubricant, spermaceti as a candle-making material, sperm and whale oils as illuminants could hardly survive the competition of petroleum products which developed after the middle of the nineteenth century, and it required the adaptation of whale oil for edible purposes by the hardening process already mentioned, to inaugurate the modern whaling era, which is largely an achievement of the Norwegians, and predominantly confined to the Antarctic.

Compared with the world's total production of oils and fats, which is estimated to exceed twenty million tons annually, even the 1931 peak production of whale oil is not considerable—say about 3 per cent.—and it is pertinent to enquire why this apparently small amount should have exercised such a disproportionate influence on the world's markets. A main point is that all the whale oil produced comes into the market, whereas a large proportion of other fats is consumed at source and is not exchanged for other goods or money. Reckoned as a percentage of the total foreign trade in fats, whale oil represents 9·4 per cent. and becomes nearly as important as butter (11·7 per cent.). It is also pointed out in the book under review that before the present war, utilization of whale oil was largely confined to Great Britain and Germany, the two leading fat importing countries.

In discussing the outlook for the future, the author concludes that from whale oil "no great new disturbance for the world's fat markets is to be expected". As far as the future of whaling itself is concerned, our present knowledge is insufficient to state exactly what rate of whale catching can be maintained without depleting the world's stocks. No new unknown seas remain for exploration and the limit of whaling must be in sight. The present volume gives an interesting discussion of all the factors

involved, with a fascinating excursus into marine biology and an account of British and Norwegian research. It is provisionally concluded that 450,000 to 500,000 tons is the maximum output that can be maintained. The history of international agreements in the past do not, however, give much hope for an effective whaling agreement in the future and it may be that there will occur fluctuating periods of excessive exploitation and enforced restriction.

This volume can be recommended as a well-documented and readable account of a subject which is by no means remote for vegetable oil producing countries like India and Ceylon; the very full statistical data are clearly presented in a number of charts and tables and the book is provided with an excellent bibliography, in which the reviewer is glad to see "Moby Dick"! One suspects that the author is indebted to Herman Melville's "Sub-sub librarian" at least for the reference to Othar the Norwegian, and for the title-page quotation from Thomas Fuller:

"The mighty whales which swim in a sea of water, and have a sea of oil swimming in them." (*Profane State and Holy State*, 1642.)

R. CHILD.

Coconut Research Scheme,
Lunuwila, Ceylon,
March 15, 1941.

CINCHONA CULTIVATION IN INDIA

BY

S. C. SEN

(*Quinologist to Govt. of Bengal, Mungpoo*)

THE production of quinine and the associated cinchona alkaloids in India has been the subject of repeated discussions during the last decade both in the legislatures and in the press. In a country, where malaria is the dominant problem in public health and a major cause of low economic efficiency, the question of an adequate supply of cheap quinine, along with that of preventive measures, is one of perennial interest.

The present position of quinine supplies in India is, without doubt, unsatisfactory. The minimum requirements of quinine in the country, as estimated by the public health authorities, are 600,000 lbs. per annum. The actual average consumption in the pre-War years has been estimated at 21,000 lbs. This enormous gap between the real or clinical demand and the effective or economic demand may be ascribed largely to the high price of quinine relative to the purchasing power of the country as a whole. The problem of a reduction of price is complicated by the fact that only a third of the present effective demand is met by production within the country. The foreign manufacturers, who supply the bulk of the Indian demand, are not particularly interested in a reduction of price, as this demand has not appreciably increased over a long period and continues to form only a small portion of the total world demand. There is a large market for quinine in Russia, the United States of America and the South American countries which can afford high prices. The Royal Commission on Agriculture in India, reported in 1925, that for India to embark on any large campaign for fighting malaria, it would first be necessary to reduce the price of quinine within the country, and this could be effected only if India were self-supporting in cinchona products.

One of the causes which may have delayed the expansion of cinchona cultivation in India is the fear of competition from Java which has great natural advantages in the growing of this exotic species. The risk of competition is not however as great as may appear. In the first place, the present standard of production in India with reference to yields and costs is certainly capable of improvement and, in the second place, there are still large tracts of land that should prove naturally suitable for cinchona. Java, moreover, is not likely to be greatly concerned about the Indian market until it expands very considerably to bear comparison with the world market.

Apart from purely commercial considerations, the quinine industry has a special interest in India. In spite of the many synthetic antimalarials put on the market in

recent years, quinine (together with other cinchona alkaloids) still holds the first place in the treatment of malaria. It is the one antimalarial which, having no pronounced toxic effects, may be administered under very simple instructions and without qualified medical supervision. It is also likely to be the cheapest remedy for a long time to come. Both these are important considerations in a country like India and quinine may well be regarded as an industry of national importance in which self-sufficiency should be the aim. The more so as, under present conditions, not only the price of quinine but also the regularity of its supply is affected by every world event which disturbs the normal courses of trade and commerce.

Public attention has again been drawn to these matters through the results, reported in 1939, of an enquiry by the Imperial Council of Agricultural Research into the prospects of cinchona cultivation in India. Mr. Wilson, the author of the report, deals exhaustively with the whole question from the historical, commercial and technical points of view. His main conclusions are:—

(*a*) that sufficient land, suitable for cinchona, is available in India to make the country largely self-supporting, (*b*) that in addition to undertakings by the Provinces and States, private planting interests should also be encouraged to grow cinchona as they are in possession of much suitable land, (*c*) that a comprehensive scheme of research should be undertaken with a view to increasing the efficiency and reducing the cost of production, and (*d*) that an organised scheme of distribution is an essential part of any forward campaign in production. To those who are interested in the development of cinchona production in India a careful perusal of this report would be worth the trouble. A reference may also be made, at the same time, to A. T. Gage's report of 1918 on the same subject.

Since the publication of the Wilson Report the Council have been engaged on the formulation of a scheme of research on cinchona references to which have been made in the press from time to time. Associated with a programme of work on fundamentals and on methods of cultivation there is also a proposal for the establishment of test plots in different parts of India and the provision of State nurseries to supply healthy young plants to new undertakings. As regards the actual extension of cultivation, the two Provincial Governments, who have hitherto been the major producers of quinine in India, have either adopted or are likely to adopt extended programmes of work. Other provinces with suitable land and some States, particularly those that had grown cinchona in the past, appear to be making preliminary investigations while the planting community, both in the north of India and in the south, are said to be willing to grow cinchona under certain conditions.

The two major factors involved in the development of the quinine industry in India are (1) an extension of areas under cultivation by various authorities in possession of suitable land and (2) an increase in the productivity of the land through careful research. An improvement in the methods of manufacture from bark to quinine need not be considered as of great importance at this stage, for the methods of manufacture practised in India have already reached a fairly satisfactory level of efficiency. In any case, further improvements in chemical and chemical engineering technique could be effected within a short time through intensive research. Extension of cultivation and research into the methods of cultivation would, however, take a relatively long period in producing results, as cinchona is not an annual crop but takes anything from 8 to 10 years to mature.

Of the two factors noted above, research, though not easy in itself, would be the simpler to organise. The problems of technique are more or less specific and capable of solution through the usual methods of scientific investigation. Research in cinchona requires the collaboration of geneticists, plant physiologists, organic chemists, soil chemists, horticulturists and statisticians. In every investigation the cost of application of positive results to the routine of cultivation should be a matter for special study and close contact will be necessary with the actual conditions of large-scale production. The problems that require attention are (1) the breeding of hardier and richer strains of cinchona, (2) the development of vegetative methods of propagation, (3) the conservation of soil and the maintenance and improvement of soil fertility, and (4) the adjustment of cultural operations and harvesting programmes to different local conditions. Long

range work is called for in some cases, while in others results may reasonably be expected within a few years. But in all cases there is need for systematic work and an early start. At least 70 per cent. of the cost of production of quinine lies in the wages of labour with regard to which there is obviously no room for economies. The major production units in India are already extensive enough to enjoy the usual overhead economies of large-scale production. A reduction of costs, therefore, can only come from an increase in the productivity of the land for which research is essential.

It is not however necessary that a programme of research should be carried through to conclusion before any extension of cultivation can be undertaken. Experience of cinchona is already available in India on which to base methods of cultivation suited to different local conditions and capable of giving results sufficiently economic in relation to world prices under normal trade conditions. Nor would it be feasible to postpone all increase of production until our methods are perfect. The need for more adequate local supplies of quinine is becoming urgent. Apart from the question of speeding up its consumption to the full limit of clinical requirements, there is an increasing pressure of current demand on Indian cinchona resources as a result of more progressive public health policies on the part of Provincial Governments, States and Local Authorities. It must also be remembered that the formation of new plantations will take time. Suitable areas will have to be decided upon, finances arranged, test plantations started, local conditions evaluated, production plans drawn up and workers properly trained in adequate numbers. It is therefore not desirable, as it is not necessary, that arrangements for an extension of cultivation should await the results of research on the improvement of methods.

Different views have prevailed from time to time as to the agencies that could best undertake the actual production of cinchona as distinct from research. The State, the industrialist and the small cultivator have all been suggested in turn as the most desirable agencies. The State agencies, namely, the various Governments both in British India and the Indian States, are directly interested in supplies of quinine. They consume large quantities through their medical and public health organisations and also assume certain responsibilities for supplies to local authorities under their administration. They have the greater portion of the total available resources in land, money and personnel. They would also require the minimum of inducement by way of net financial gain. The industrial agencies may be taken to consist mainly of the plantation interests and the manufacturing chemists and pharmacists. The former, in many cases, possess the land and capital and some practical experience; the latter might, in some instances, wish to acquire plantations but would, in the main, be probably content to confine themselves to the manufacture of quinine from bark produced by others. The immediate as well as the ultimate inducement to private enterprise would have to be more attractive than to State enterprise as the former would require more adequate returns on capital. As a cottage industry cinchona is likely to prove wasteful, for the small cultivator would be generally handicapped for want of technical knowledge and adequate resources and would, moreover, have frequent temptations of realising his assets before maturity. There has been some difference of opinion in the past as to the desirability of private enterprise in cinchona as compared to State enterprise, but considering the present distribution of control over the total resources in production, it is probable that both private and State agencies will have to come into the field before really adequate supplies of quinine are assured to the country.

This view is supported by a consideration of the average yield of quinine that may be expected from the Indian plantations. The yield, according to Mr. Wilson, may under present conditions be taken as 180 lbs. of quinine sulphate per acre over a period of 12 years. This is equivalent to 15 lbs. per acre per annum. To produce the estimated minimum requirement of 600,000 lbs. per annum it would, therefore, be necessary to have a crop-bearing area of 40,000 acres. This, however, does not represent the gross total of necessary plantation areas. A margin of cropable area must be allowed to ensure a periodic rest to the land under alternative crops. Land will also be required for the housing of labour and staff, for buildings and roads and for the production of subsidiary raw materials like timber and fuel and bamboo and thatch. Further,

most plantation areas, being in the hills, would naturally be interspersed with much waste land by way of streams, ravines, precipices and rocky or wet patches. It is not easy to make an estimate of the total gross area required, for conditions will vary from place to place. But 120,000 to 150,000 acres may be taken as a very approximate figure. Mr. Wilson's estimate of the available first class cinchona land is 38,000 acres. From the nature of his calculations this appears to represent the net cropable area as distinct from the gross area available for the formation of plantations. In spite of this and in spite of his mention of large tracts of second class land in various parts of India which under certain conditions it might be profitable to exploit, he is not at all happy about a sufficient margin of safety. He therefore suggests, though only indirectly, that steps should be taken to ensure the utilisation of all first class cinchona lands for growing this crop alone. This is a matter that deserves serious consideration.

Mr. Wilson has made an extremely helpful survey of the general land position. But the very importance of his conclusions requires it to be followed up by a more detailed survey with reference to localities, acreages, soils and climatic conditions. There is the need for a proper assessment of the second class areas mentioned by him, particularly those in Assam. There is also need for a grouping of the available areas into compact plantation units on an economic scale. Such a survey would require the co-operation of all who are in possession or occupation of suitable land and the proposed test plots could form the centres from which the technical portion of the survey might be undertaken.

A rational long-period policy for India as a whole can only be based on a complete knowledge of our ultimate resources, though the rate at which such resources could be developed would depend on circumstances. Even for individual production schemes of any appreciable size the preparation of efficient working plans requires the collection of data in greater detail than available at present. A broad co-ordination of regionally separate and economically independent schemes is not a mere counsel of perfection. If the distressing conditions that have overtaken many of the plantation industries in recent years are to be avoided in the case of cinchona, there is no doubt that production should be developed from the earliest possible stage, on an all-India basis instead of through a multiplicity of competitive schemes. This is the more important in view of the fact that cinchona is a long period crop and any appreciable maladjustment of short period supply and demand would take time to correct itself resulting in considerable hardship to the producer or the consumer as the case may be.

Though there is no danger of an ultimate overproduction of cinchona in India, no production scheme can afford to be divorced permanently from the question of distribution. It must be remembered that the effective or economic demand in India is quite small at present and requires to be stimulated as much as production needs to be increased. This effective demand comes not directly from the malaria stricken population who are generally too poor to afford quinine at any price, but from the medical, public health and local authorities, who have certain responsibilities with regard to public welfare, as well as large employers of labour who find it paying to keep their workers in good health. It is to these that the cinchona industry in India must look for a proper development of consumption until there is an appreciable improvement in the general economic level of the country. A healthy co-relation of supply and demand will therefore depend, more on a deliberate co-ordination of production with all medical, public health and public activities against malaria than on the play of normal forces in trade and commerce. It is not difficult to visualise an organisation of producers, distributors and consumers for the regulation of the cinchona industry in India, each helping the others; but the initiative must come from a source of influence and prestige.

To turn from the ideal of a programme of balanced production and distribution, the immediate problem is a stimulation of production by inducing a number of potential undertakings to make a start. The present scarcity of quinine supplies which is likely to last for some time, together with the rising trend of consumption already mentioned, should be a strong incentive for action. Further incentive may be provided through well-informed propaganda. A very practical and effective form of it would perhaps be the establishment, on a regional

basis and under a variety of natural conditions, a number of model plantations which, run on commercial lines, should afford concrete examples of the possibilities of large-scale production. Some of the test plots, the maintenance of which is now under consideration of the Imperial Council of Agricultural Research, could form the nucleii of such model plantations. Both the test plots and the model plantations, which must necessarily be run with the utmost possible efficiency, would require the careful training of workers towards which a central research organisation should be able to render valuable help.

Every successful new undertaking will act as an incentive to others, but every failure is also likely to retard the general progress. It is therefore necessary that all possible precautions should be taken, specially in the early years, against the risk of failure through a lack of experience. This is the reason why Mr. Wilson proposed his State Nurseries, propagation being one of the most difficult things about cinchona cultivation. For the same reason there would also appear to be need for an advisory service to help newcomers in the field with choice of land, choice of species and other technical matters relating to the initial stages of forming a plantation. That such a need has already been felt is clear from the numerous enquiries that have recently come from various parts of India to the existing cinchona administrations. Proper attention to such enquiries is possible only for a special organisation with sufficient time and facilities at its command, and the idea of an advisory body, consisting of specialist research workers as well as men with practical experience of cinchona, naturally suggests itself.

India's need for adequate supplies of quinine is urgent. The times are favourable for the development of an indigenous industry. What would appear to be necessary is the formulation of a co-ordinated scheme of work and the pooling of all resources in its execution.

AQUARIUM AND MARINE BIOLOGICAL LABORATORY OF THE UNIVERSITY OF TRAVANCORE

BY

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IT has been the experience of many biologists, that facilities for researches on aquatic biology are very limited, if not entirely lacking in India. There is not a single institution in India which may be compared to the Biological Stations in Europe, America or Japan,[1] *i.e.*, a station where aquarium facilities are provided for the convenient study of physiological and bionomical problems relating to aquatic organisms. There are laboratories without aquarium facilities, and, aquaria without laboratory convenience. Owing to the lack of this essential combination, the Indian biological laboratories have been concentrating mostly on anatomical or histological problems, while the few existing aquaria have functioned purely as show places of a popular character. The gravest consequence of this state of affairs was that our fisheries have not benefited in any appreciable manner through the researches of our biologists. Our fisheries still continue in the primitive condition, in which they existed during the times of our forefathers hundreds of years ago, while the fisheries of Europe, America and Japan have progressed with rapid strides, through the incorporation of scientific knowledge and scientific experience in all branches of the industry. This handicap has compelled us very often to copy blindly the methods of other countries, without testing whether the adoption of such methods will suit our local conditions and requirements. Unlike other positive sciences, results of applied biological work carried out in one country may not be of any practical value to another country. For example, the life-history of the herring, cod or salmon or the method of artificial propagation of the white fish, grayling or shad may not help us to solve the problem of our sardines, mullets, seer fish or prawns. The study of the ocean currents, temperature, salinity and related oceanographical problems in other countries will not enable us

to draw inferences regarding these factors of our seas. Types of fish and their habits, nature of the sea and the organisms found therein vary according to geographical conditions, so that, if any country desires to develop its fisheries, it must organise its own scheme of researches. This necessity has long been felt and the profound scientific importance of a combined aquarium and laboratory for the convenient study of not only anatomical and physiological problems in aquatic botany and zoology, but also the habits and environments of marketable food fishes, has long been realised, and the opinion of scientific bodies was being slowly shaped towards the establishment of such an institution. It was at this juncture that the University of Travancore decided to organise a biological station to provide scope for the study of aquatic biology and fisheries.

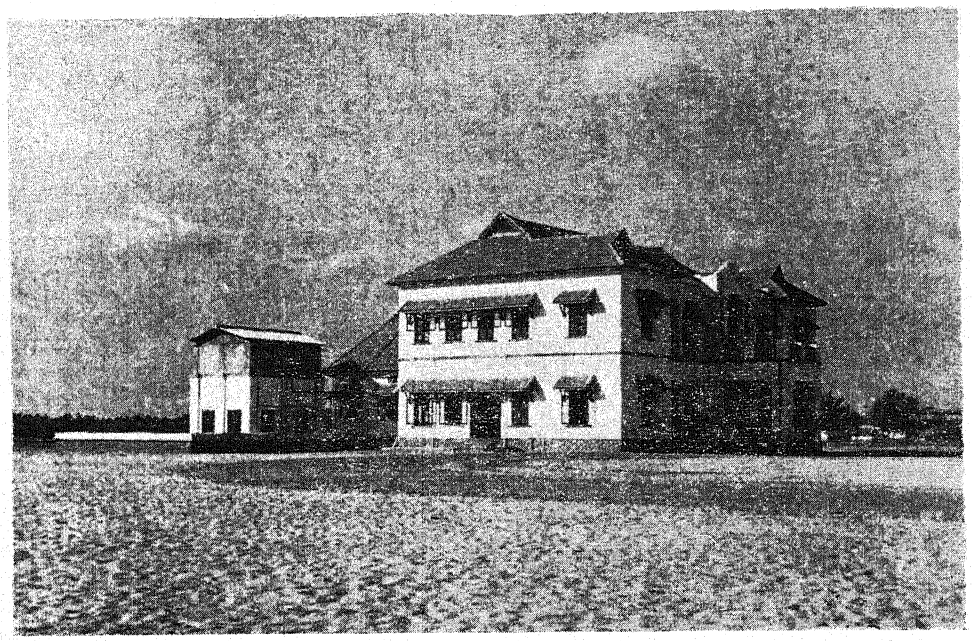


FIG. 1

General view of the Aquarium and Marine Biological Laboratory

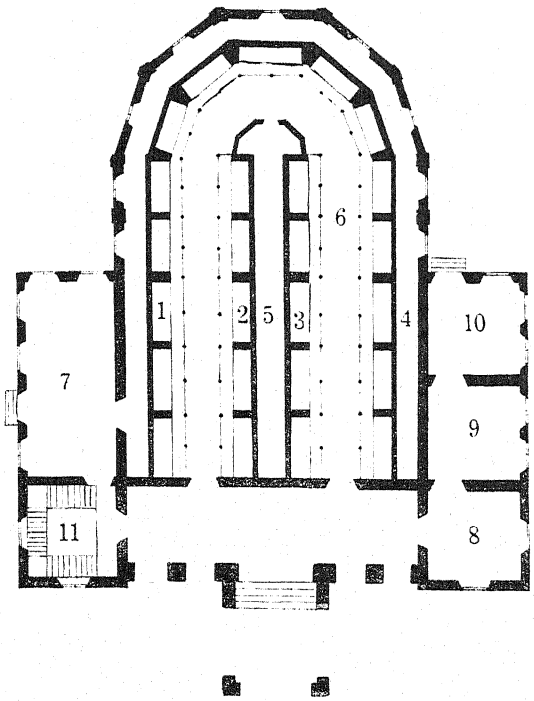
Unlike any other locality which may be selected for the situation of such an institution, the site chosen for this laboratory is most ideally suited for the purpose in view, since it offers convenience for the study of not only marine biology but also every type of aquatic life, including brackish water and river fauna. The laboratory is situated at a distance of only 1,500 feet from the sea and in the vicinity of two important lakes and a river.

Two miles to the north of the laboratory is the backwaters of Veli and a few miles further north is another much larger backwater called Kadinumkulam lake. Both these backwaters are rich in fisheries and every type of brackish-water fauna, which may interest students of biology. About two miles to the south of the laboratory the Karamanai river flows into the sea, and a short distance further south is one of the few important freshwater lakes called Vellayani. For marine collections also Trivandrum is ideally suited. The laboratory has under its control a good seaworthy canoe and two experienced fishermen, who daily bring to the laboratory collections of plankton and fish. The pier at Trivandrum and the beautiful palm fringed promontory of Kovalam about two miles south of the pier, with scattered boulders and rocks jutting into the sea afford convenience for collections of every type. Thus it will be seen that every conceivable type of aquatic fauna is within easy reach of the laboratory, and in order to accommodate all these aspects of work both the aquarium and the laboratory provide the necessary facilities.

THE AQUARIUM

The aquarium is situated on the ground floor of the building and it has been designed on the most up-to-date lines, incorporating all the latest improvements in aquarium construction. The entrance to the aquarium

is from a wide verandah 45′ by 18′ and in the centre of the facing wall of this verandah is a large bas relief figure of *Matsyavathar*, symbolising the slow emergence of the higher forms of life from aquatic ancestors, and imparting a somewhat religious atmosphere, which is harmonised by the general architectural design of the whole building.



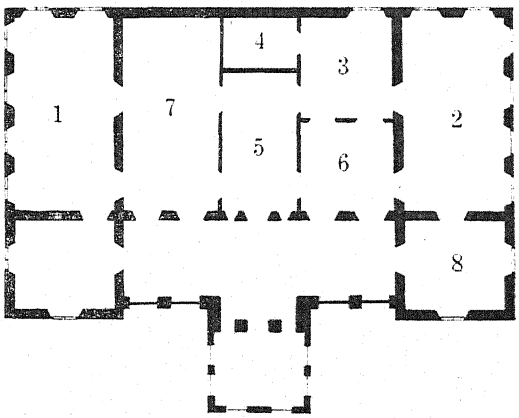
Plan of the Ground Floor

1. Sea water tanks. 2. Fresh water tanks. 3. Brackish water tanks. 4. Service corridor of sea water tanks. 5. Service corridor of Brackish and Fresh water tanks. 6. Visitors' corridor. 7. Curator's office and preparation room. 8 9 & 10. Office of the Department of Fisheries. 11. Stair-case room.

The aquarium hall is 75′ by 45′ and takes the form of a crescentic gallery 134′ long with tanks on each side. On the sides there are fifteen sea-water tanks while the central part is occupied by two parallel longitudinal rows, with seven tanks in each row.* Thus there are altogether twenty-nine tanks, of which all excepting six small tanks are meant for the display of rare and interesting forms of aquatic life.

The outer tanks are constructed 3½ feet away from the side walls of the aquarium hall, thus providing a continuous 'service corridor' for the sea-water tanks. A similar 'service corridor' is also provided between the two central rows of tanks, which are meant for fresh-water and brackish-water fishes respectively. This arrangement enables employees of the aquarium to attend to the tanks without causing inconvenience to the visitors.

The side and back walls of the tanks are constructed of reinforced concrete and plastered internally with blue cement mixed with water-proofing material, while the front of the tanks is fitted with 1-inch thick glass plates specially manufactured for the purpose by Messrs. Pilkington Brothers, England. Since variations in temperature during any part of the year are not very considerable, the glass plates have been simply built into the concrete without any precautions against expansions or contractions. The upper edge of each glass plate is held in position by a reinforced concrete beam and from the top of this a wooden screen extends right up to the ceiling. This screen cuts off view of the service corridor from the visitors' gallery and also prevents light from the illuminating sources above the tanks from passing directly into the visitors' gallery. The visitors' gallery is not lighted as a rule, while the tanks are lighted from above from invisible sources. As a result of this arrangement the visitors get a series of brightly illuminated pictures of the under water world, but apart from this scenic effect it also satisfies an essential condition in the proper care of fishes.



Plan of the First Floor

1. Junior laboratory. 2. Senior laboratory. 3. Chemical laboratory. 4. Photographic dark room. 5. Common room. 6. Library. 7. Fisheries industrial museum. 8. Office of the Professor of Marine Biology and Fisheries.

The inner surface of the wooden screens, the walls and ceiling of the aquarium hall are all painted light blue, while the outer surface of the screens, *i.e.*, the surface facing the visitors' gallery is painted with a series of submarine sceneries, depicting rare and

* The last tank in each central row is divided into smaller tanks, not shown in the figure.

interesting varieties of fishes and other marine forms of life in their natural surroundings and colour.

The visitors' gallery is 15 feet wide and is bounded on each side by barrier rails, which have been provided for the safety of the glass plates. The total capacity of the fifteen sea-water tanks is 12,600 gallons while the combined capacity of the brackish and fresh-water tanks is 8,400 gallons. Thus it will be seen that both in regard to size, number of tanks and their total capacity this aquarium is the largest on the mainland of the Asiatic continent.

Circulation of Sea Water

The circulation of sea water is based on the Lloyds system in which the same sea water is always in circulation, thus avoiding the necessity of pumping water from the sea daily.

Sea water is stored in a large underground reservoir 35′ by 25′ by 8′ having a capacity of about 49,000 gallons. By a median vertical partition, this reservoir is divided into two longitudinal halves to facilitate cleaning any one half without interfering with the continuity of circulation. From this main reservoir water comes into a mixing reservoir in which fresh water is added to sea water to compensate for losses by evaporation and to keep the salinity constant. Originally it was planned to connect an evaporimeter above the rows of tanks to determine the quantity of fresh water to be added, but as this was not available, owing to the present international situation, addition of fresh water is effected by calculating the salinity of sea water in the tanks at regular intervals.

From the mixing reservoir a 5-inch cast iron suction pipe, fitted with a foot valve, leads into the pumping set. The housing and impeller of the pump, with which sea water comes into contact, are made of hard phosphor bronze, while the delivery pipe is of cast iron. This delivery pipe discharges into a reinforced concrete overhead reservoir 18′ by 12′ by 8′ with a capacity of about 9,000 gallons. From this reservoir water is led into the aquarium hall through 4-inch asbestos cement pipe, which is tapped at regular intervals above each aquarium tank, with ½-inch lead pipes, screwed to the sides, with brass ferrules. The distal ends of the lead pipes are drawn out into narrow jets. As this arrangement enables water to fall into the exhibition tanks with considerable force drawing a good amount of air bubbles along with it, it ensures efficient aeration of water as long as circulation is maintained. However, as a precautionary measure arrangements have also been made for the supply of air to each tank, from a suitable air compressor.

The overflow water from the exhibition tanks is led through 1-inch lead pipe into a cement conduit, which at its farthest end is connected with a 4-inch asbestos cement pipe, through which it flows into the filter tank. The filter bed is formed of five layers of loosely laid bricks, one layer of road metal, 1 foot thick, a layer of gravel, 1 foot thick, and a layer of sand, 2 feet thick, the sand forming the topmost layer. Through this filter, water percolates from top to bottom and flows directly into the underground reservoir, from where it is drawn again through the mixing reservoir into circulation.

One of the advantages of the filter system is that it reduces the nitrogen contamination to a great extent. The chief impurity of the aquarium water, compared with that of the open sea, lies in the excessive quantity of nitrogen present in various forms and in reduced alkalinity. The excess of nitrogen is referable to dead animals or waste food and excreta of living animals. The first two of these sources of contamination are reduced with care and cleanliness and maintenance of a flow of water sufficient to prevent excessive accumulation of sediment, and by the addition of lime and lactate at regular intervals.

Sea water in the underground reservoir is renewed once in three months or at shorter intervals as need arises. For this purpose a temporary pump is erected on the seashore, and water is conveyed to the underground reservoir through 1,800 feet of 4-inch stoneware pipe specially manufactured by the Travancore Ceramic Factory.

Brackish water necessary for esturine fishes is prepared by mixing up fresh water and sea water in the required proportion. This is stored in an underground reservoir and circulated in the same manner as sea water.

Water for the fresh-water tanks is drawn from a well and the overflow water is allowed to percolate through loose sand back into the well, so as to conserve supply even during dry months.

Laboratory

The research section is accommodated in the first floor of the building, and the general arrangement is shown in Plan 2. It consists of two large biological laboratories,

a chemical laboratory, library, common room, a photographic dark room, fisheries industrial museum and the office of the Professor. The laboratories are provided with twelve bench spaces and adequate fittings for biological work. The chemical laboratory is not fully equipped but as soon as circumstances permit arrangements will be made for providing all the apparatus and chemicals necessary for oceanographical work. The number of books in the library is at present very limited; however, the central library of the University and the museum possess a number of important biological journals which are always available for use in this laboratory.

Though the main purpose of the laboratory is the study of problems having a direct bearing on the commercial fisheries, facilities are also provided for researches of a more general or fundamental nature concerning life in the sea and inland waters. The varied shore line of Travancore, and the numerous backwaters and rivers support an extensive and varied fauna, which affords opportunities for practical study of every aspect of aquatic biology, and the constant supply of these collections makes the laboratory particularly suitable for such research. The laboratory as a whole therefore now offers facilities for all kinds of biological work, and it is hoped that these facilities will be used not only by students of the Travancore University, but also by visiting research workers from other Indian Universities.

[1] See B. K. Das, *Curr. Sci.*, 1940, **9**, 110.

CENTENARIES

Richardson, Richard (1663-1741)

RICHARD RICHARDSON, a British botanist and antiquary, was born at North Bierley 6 September 1663. He studied at Bradford School and at University College, Oxford. In 1671 he entered the Gray's Inn. Later in 1687 he went to Leyden and studied Botany under the celebrated Professor Paul Hermann. When he returned home, he practised medicine but did not take fees, as he had ample means at his command.

His main interest was in botanical travels. His garden was considered the best collection of his days. He is reported to have constructed the second hot-house in England. He also collected a valuable library of botanical and historical books.

He was elected F.R.S. in 1712. He made several contributions to the *Transactions* of the Royal Society.

Richardson is acknowledged as having enlarged the list of British plants by persistent travel and investigations throughout the British Isles. He is also said to have fixed the habitats of several specimens.

Richardson died 21 April, 1741.

Sargeant, Charles Sprague (1841–1927)

CHARLES SPRAGUE SARGEANT, an American arboriculturist, was born in Boston, Mass., 24 April, 1841. After graduating from the Harvard University in 1862 and spending some years in the army, he travelled three years in Europe. When he returned to his native land he occupied himself for a time with the development of his garden. This specialisation led to his appointment in 1872 as the Director of the Botanic Garden of his University and first as professor of horticulture and later, that is, from 1879 as professor of arboriculture in the same University.

In 1873 Sargeant was appointed director of the Arnold Arboretum, which was newly created through an agreement between the Harvard University and the testators of James Arnold, a New-Bedford merchant who had died in 1869. The University set aside 125 acres of land and received from Arnold trustees a little over 100,000 dollars the income from which was to be used for the development and maintenance of a plantation in which practically all of the trees, shrubs and herbaceous plants in the region were to be grown and labelled. Tree knowledge was also to be taught to students.

Sargeant devoted his entire energies to this work and converted the original worn-out farm partly covered with natural plantation of native trees nearly ruined by excessive pasturage into a beautiful park in which 6,500 named species of choice trees and shrubs grow as representatives of 339 genera. An incredible number of hardy plants have been introduced into American and European cultivation through the agency of this Arboretum. To-day it stands foremost in its field.

Synchronously with these foundations for dendrology a library was established which has now grown to 40,000 publications on woody plants—largely at Sargeant's own expense. Sargeant's special field of research was ligneous plant. The fourteen volumes of the *Silva of North America* (1891–1902) with illustrations of every species of tree then known north of Mexico is unequalled in its value. The *Woods of the United States* (1885) and the *Report on the forests of North America* (1884) forming volume 9 of the Tenth Census are his earlier works. Sargeant's full bibliography exceeds 200 items. His very latest publication (1927) fittingly deals with the realised idea of his life: *The greatest garden in America, the Arnold Arboretum.*

Sargeant died 22 March 1927.

S. R. RANGANATHAN.
University Library,
Madras.

POLYGALA SENEGA LINN.

POLYGALA SENEGA belongs to a widely distributed family *Polygalaceæ* which consists of 10 genera and nearly 700 species spread all over the world with the exception of New Zealand, Polynesia and Arctic Zone. Most members of this vast family are more or less toxic and expectorants, some bitter and emetic, and a few acrid and poisonous.

P. senega is a plant of the Central and North America. The dried roots (senega snakeroot) as they appear on the market are irregular, twisted and taper from a thickened tuber bearing the remains of the small stem. The root bark is yellowish in colour, with a peculiar, somewhat rancid, odour recalling that of gaultheria. Taste is acid, sweetish and somewhat acidic.

Senega root which is tonic, expectorant and emetic, normally contains 3–4·5 per cent. of a mixture of saponin, a neutral saponin senegin ($C_{30}H_{50}O_7$) and an acid saponin polygolic acid ($C_{30}H_{48}O_{10}$)[1]; a volatile oil (about 0·3 per cent.) which has been identified as methyl salicylate and valerate[2] and free salicylic acid (0·06 per cent.). The root contains about 5 per cent. of a fixed oil (Sp. gr. 0·9616 at 18° C.) consisting of olein (74 per cent.) palmitein (8 per cent.) and a little valerein.[3] Apart from the above a small quantity of a glucoside gaultherin has also been traced.

The constituents on which the pharmaceutical value of senega depends are the saponins and the glucoside gaultherin which on enzymic hydrolysis yields the methyl salicylate in the plant. These constituents are found in varying proportions in the following species.

1. *Neutral and acid saponins*:
   In the root of *Polygala amara* Linn., *P. alba* Nutt. (Bastard senega), *P. senega* Linn. (snake root) and *P. tenuifolia* Willd. (Japanese senega).
   In the root barks of *P. major* Jocq., *P. angulata* DC., *P. boykini* Nutt., *P. Caracasana* HBK, *P. diversiifolia* Linn., *P. latifolia* Torr., *P. pavciflora* Willd., *P. purpurea* Nutt., *P. sanguinea* Michx., *P. chambœbuxus* Linn., *P. monticola* H. et B., *P. virginica*, *P. paniculata* Linn. and *P. vulgaris* Linn.
2. *Methyl salicylate*:
   In the root and root bark of *P. senega* Linn., *P. senega* L. var *latifolia* Torr et Gr., *P. boykini* Nutt., *P. rarifolia* DC., *P. javana* DC., *P. variabilis* HBK, *P. baldwinii* Nutt., *P. serpyllacea* Weihe, *P. calcarea* Schultz, *P. depressa* Wend, *P. alba* Nutt., *P. oleifera* Heck, *P. violacea* St. Hil, *P. vulgaris* Linn., *P. tenuifolia* Willd. and *P. amara* Linn.

Those species which have both the saponins and the methyl salicylate, therefore, are *P. senega* Linn., *P. boykini* Nutt., *P. amara* Linn., *P. tenuifolia* Willd., and *P. vulgaris* Linn. Consequently these are the ones which are officinal in various pharamacopœias. Roots of *P. senega* Linn. is officinal in Europe, Great Britain, and United States of America, root of *P. tenuifolia* Willd. in Japan, root of *P. vulgaris* Linn. and flowering tops of *P. amara* Linn. in Portugal.

Apart from the officinal species many others are stated to be used medicinally. These are *P. calcarea* Schultz, *P. major* Jocq., and *P. serpyllacea* Weihe in Europe; *P. sanguinea* Michx and *P. alba* Nutt. in North America; *P. paniculata* Linn. in Brazil; *P. myrtifolia* Linn. and *P. tenuifolia* Willd. in South Africa and *P. Siberica* Linn. in China, Japan, Indo-China and Malaya.

The common adulterants of *P. senega* are twigs and shoots of *P. senega*, the root of *P. alba* which contains 1 per cent. senegin and some methyl salicylate,[4] *Parrax quinquefolius*, *Cyperipedium pubescens* and *Ionidium ipecacuanha*.[5] Grimme[6] has suggested that senega, the active principle of which is saponine can be replaced by radix primulæ.

In India the following polygala have been used in the indigenous system of medicine:—

P. crotalarioides Ham [*Vern* Nilkanth (Hind) a perennial herb of temperate Himalayas), *P. chinensis* Linn. [*Vern* Common Indian milk wort (Eng.), Merudu or Miragu (Hind) an annual herb found throughout India upto 5,000′], *P. telephioides* Willd. (an annual herb found in Carnatic, Nellore or Travancore) *P. glomerata* Lour. (found in Sikkim, Assam and Khasia Hills) and *P. sibirica* Linn. syn. *P. Heyneana* Wight and Arn (found in temperate and sub-tropical Himalayas, N.W.F. Province, Punjab, Khasia Hills and Western Ghats chiefly above 6,000′).

Dymock in *Pharmacogrophia Indica* remarks that *P. telephioides* Willd. and *P. chinensis* Linn. "like senega owe their medicinal properties to the presence of a substance closely related to, if not identical, with saponine". Based on these remarks Watt, in *Dictionary of Economic Products of India* states that "Indian species of polygala may prove efficient substitutes for *P. senega*, which is neither a native of this country nor cultivated here".

There is no chemical literature on any of the Indian polygala and it is, therefore, impossible to say as to which of these may be a substitute for *P. senega*. It is possible that *P. sibirica* of Indian origin may be found to contain the same active constituents as the Japanese species which in that country is used medicinally. Nothing, however, can be stated with any confidence in absence of any published work.

S. KRISHNA.

[1] Kobert, *Arch. Path. Pharm.*, **23**, 233.

[2] Reuter, *Arch. Pharm.*, **27**, 309.

[3] Schroeder, *Arch. Phrrm.*, **243**, 628.

[4] Maish, *Amer. J. Pharm.*, 1892, **177**, Rusby, *Bull. Pharm.*, 1892, 163.

[5] Tunmann, *Pharm. Central.*, **49**, 61.

[6] Grimme, *Munch. Med. Wochschr.*, **69**, 50.

SCIENCE NOTES AND NEWS

Chemical Constants of Lac.—The London Shellac Research Bureau has published a bulletin entitled "Chemical Constants of Lac—Some Notes on the Acid, Saponification and Hydroxyl Values of Lac", copies of which may be had from the Indian Lac Cess Committee.

The bulletin shows that the acid value of lac has been determined with three different indicators: Alkali Blue 6B as an internal indicator gives a sharp end-point, and it has been found preferable to use 0·1N alcoholic potash for titration instead of the customary 0·5N.

At least four hours' heating on a water-bath with 0·5N alcoholic potash is necessary to effect complete saponification, further complete saponification is not obtained with absolute alcoholic potash; the presence of water is necessary; and optimum results are obtained with 10 per cent. of water in the alcoholic potash.

For determination of the hydroxyl value of lac, Normann's method has been found convenient and gives reliable results, but it is necessary to allow at least four hours' refluxing with 0·5 N., 90 per cent. alcoholic potash to saponify completely the acetylated lac product.

A New Method for the Preservation of Vegetables.—In addition to the two universal methods of canning and drying vegetables, a new form of preservation has come to light. This is compressing vegetables.

It has been claimed that each pound of compressed vegetables is equal to approximately 12 lbs. of finest fresh vegetables and in this form will keep for an indefinite period under any climatic conditions.

Luminous Paints.—The possibilities of manufacturing luminous paints from Indian ores and from calcium, strontium and barium sulphides at fairly cheap prices, have been indicated by the work carried out at the Alipore Test House, Calcutta. These paints have already been tried in the air raid precaution measures in Calcutta and a demonstration of their effects has been arranged at the Government Test House, Alipore.

The importance of luminous paints was realised in the last Great War, when they were employed for illuminating aeroplane dials, gun sights for night firing, and numbers of vehicles and cycles. The present war, with the increased effectiveness of the bomber and the necessity for black-out restrictions, has given a great impetus to the study of the production of cheap luminous paints.

Paints from Indian Sources.—At least a dozen paint factories are operating in India to-day. These are producing dry colours, paste paints, mixed paints, enamels, varnishes, and oils (excluding raw linseed oil)—virtually every kind of paid manufacture from cheaper qualities to meet the demand of the Indian bazaars to the production of highly specialised qualities for use by railways, shipping, and industrial organizations of all descriptions.

They can also manufacture paints required for war purposes including anti-vesicant, camouflage, and fire-retarding paints.

In addition to paints for such diverse purposes as the protection of bridges or the decoration of India's palaces, a wide range of specialized finishes is produced for industrial purposes. These include synthetic and natural gum enamels and varnishes, vegetable oils, both heat- and chemically-treated and stabilized emulsions of various types, their application ranging from the painting of railway passenger coaches to the water-proofing of indigenous cotton canvas.

Modern research is helping Indian paint industry in many ways. In the laboratories of the Director of Scientific and Industrial Research, has been developed a technique for manufacturing varnishes and paints from the bhilawan nuts to the satisfaction of the trade. The film is more flexible and resistant to shock than that given by any other product in the market.

The Indian Institute of Science has completed research on the manufacture of pigmented lacquers in powder form and the Department of Director of Development, Cuttack, for lacquers on wood. Bleached lac, an important article in the plate varnish and nitro-cellulose lacquer industries and hard lac resin for the varnish and electrical industries have been produced at the Indian Lac Research Institute.

As a result of researches carried out at London and Namkum, several processes of making varnishes from shellac and drying oils have been discovered.

The College of Science in Nagpur, is making attempts to manufacture white lead paint, as well as metal and wood polishes.

The indigenous product has many advantages over the imported articles, for Indian paints, enamels and varnishes are manufactured under the actual conditions in which they are ultimately intended to be used. The factories are now practically all equipped with chemical testing laboratories and control testing rooms, where highly skilled chemists and other workers give specialised attention to each product and the particular problems arising in its general use.

In addition to meeting the growing demand for paint and paint products in this country, Indian supplies have been regularly exported to Burma and Ceylon. With the outbreak of the war, however, additional demands are being made upon the Indian industry and in recent months exports have been made to the Near and Far East, to Persia, Mesopotamia, Africa, Siam, Singapore and the East Indies.

Agricultural Research on Jute.—An important step in the development of agricultural

research on jute in this country has been taken by the establishment of three Agricultural Research Sub-stations by the Indian Central Jute Committee at Kishoreganj (Mymensingh), Konda (Brahmanbaria) and Narayanganj. These centres are situated in some typical and representative jute-growing areas, and according to a press note recently issued by the Indian Central Jute Committee, have started to function from the beginning of this month.

Agricultural Research workers now fully realize that plant-breeding work to be fruitful must be carried on under representative conditions; it is the object of the Central Jute Committee's Research Sub-stations to provide such conditions. They will be run by trained field staff under the control and supervision of the Committee's Director of Jute Research Laboratories at Dacca. The Government of Bengal through the Department of Agriculture are co-operating with the Central Jute Committee in this work, and have already agreed to contribute half the non-recurring and recurring cost of this scheme.

Par-boiled Rice for Troops.—As par-boiled rice is richer in proteins and minerals, it has been decided to make a trial issue to troops to test its palatability, etc. This rice has better keeping qualities and is more economical than the raw milled rice. It is understood that 57 per cent. of the total quantity of rice grown in India is par-boiled before being placed on the market.

Flax Substitute.—A flax substitute "celin" which has selected jute as a base, has been manufactured in Northern Ireland, according to the March issue of the Indian Central Jute Committee's *Bulletin*.

It is claimed that the new fibre can be spun, woven and finished on orthodox flax machinery and is cheaper than flax. Conversion of jute into "celin" is performed by chemical means in a series of tank treatments which take only a few days. Subsequently, it is rolled to the required degree of softness, dried and ready for delivery to the flax spinning mills.

"Celin" has been successfully used as weft in the production of practically all classes of domestic goods and pure "celin" warp and weft have been used in the production of canvas, which is claimed to be better than the cotton-jute union fabric evolved in India.

Another possible new use for jute is in the production of felt. It has been found that thermoplastic fibres such as vinyon can be utilised to produce felts from mixture with other fibres such as glass, asbestos, wool, hair, jute, cotton and rayon, of which jute is the cheapest. By varying the proportions a range of products from soft wadding-like insulating materials to hard flexible tilling can be produced.

Indian Food Fishes.—With the aim of dividing the chief varieties of Indian "food" fish into well-defined groups, the Agricultural Marketing Adviser has compiled and published a "Preliminary Guide to Indian Fish, Fisheries, Methods of Fishing and Curing". The guide is primarily intended for lay-men and instead of minute scientific descriptions provides a catalogue of important characteristics, distinctive markings, peculiarities of shape and other data to enable the lay man to recognise the fish. There is a diagram on art paper of each of the varieties described.

The principal Indian fisheries and the gear used are described at length and illustrated with a number of plates. Many of the implements in use have not changed for nearly a century. In the back-waters of Malabar and South Canara, for instance, the fishermen still use the cross-bow and blow-gun, the fish-spear is used on the Ganges and other rivers to catch cat-fish, while sharks, rays and dolphins are caught off the west coast with harpoons thrown from canoes.

College of Pharmacy.—According to an Asscciated Press message dated March 19, 1941, the College of Pharmacy Committee appointed by the Government of Bengal with Sir R. N. Chopra as Chairman, has recommended the establishment of a College of Pharmacy in Calcutta.

It is recalled that Dr. D. E. Anklesaria of Ahmedabad agreed to donate a sum of Rs. 2,00,000 to the Government of Bengal for the establishment of such a college.

The Indian School of Mines, Dhanbad.—Of the 21 students who qualified at the Indian School of Mines, Dhanbad, 18 have been placed in employment or are undergoing apprenticeships and one has gone abroad for specialised studies, according to the Annual Report of the School for the year 1939–40, just received.

Recent employment enquiries show that there is increasing demand for specialists, especially in fuel technology and metallurgy. Of the students in employment, two have been sent by their employers to attend advanced courses elsewhere in metallurgy.

The annual Mining Survey Camp was held in November, 1939, at Sijua Colliery, 69 students being under canvas. The Geological Survey Camp was held at Gondhudih Colliery.

The senior geological students went on two educational tours, one in the Hazaribagh, Ranchi and Singhbhum districts and the other in the Northern India Salt Range.

The total number of mining students annually visiting the mining districts, during long vacations, for practical experience, is constantly on the increase. Formerly it used to be between 30 to 40, whereas now the number from the Indian School of Mines alone is over 75 and is increasing. Most of the mining concerns have given and continue to give valuable support in this connection.

Owing to shortage of funds and war-time restrictions, the research activities have been curtailed. The work on washability of coals and the crystallographic investigation of vitrains of Indian coals were, however, continued.

Botanical Society of Bengal.—The Fifth Annual General Meeting of the Society was held on the 22nd February 1941, at the Botanical Laboratory, University College of Science, 35, Ballygunge Circular Road, Calcutta.

Prof. S. P. Agharkar, President of the Society took the chair.

The Hony. Secretary (Mr. S. N. Banerji) presented the Annual Report.

The following were duly elected Office-bearers and Members of the Council for the year 1941–42:

President: Prof. S. P. Agharkar; *Vice-Presidents*: Prof. S. C. Mahalanobis, Prof. G. P. Majumdar, Mr. S. N. Bal, Dr. K. P. Biswas; *Hony. Treasurer*: Mr. I. Banerji; *Members*: Dr. S. R. Bose, Dr. J. C. Sen Gupta, Prof. J. C. Pal, Prof. M. B. Dutta, Prof. M. L. Chakravarty, Dr. N. K. Chatterjee, Mr. E. A. R. Banerji, Mr. R. M. Datta, Dr. J. Chaudhuri; *Hony. Secretaries*: Dr. S. M. Sircar, Dr. B. C. Kundu; *Hony. Auditors*: Mr. J. C. Banerji, Dr. J. B. Mukherji.

An exhibition and a conversazione were organised on the occasion. The list of exhibits included fossil plants, economic and horticultural plants, different strains of rice and sorghum and their hybrids, mulberry with reference to silk-worm rearing, Marine Algæ, Mycology and Plant Pathology, Pteridophytes, Gymnosperms, Cytology. Several experiments showing life processes in plants, different kinds of vegetable fibres, medicinal plants and drugs, Himalayan plants, Alpine flora, Khasi Hill flora, Mangrove vegetation, Parasitic seed plants, Insectivorous plants and Bengal timbers.

A whole day excursion was organised to Sundribans Forest *via* Gosaba, on the 23rd inst. where a rich collection of the mangrove vegetation was made.

The National Academy of Sciences, India.—At the meeting of the Council held on Friday, 21st March 1941, the following resolution was passed: "This meeting places on record its deep sense of sorrow and grief on the sudden and untimely death of the Hon'ble Sir Shah Muhammad Sulaiman, Judge of the Federal Court of India, Ex-President and Senior Vice-President of the Academy, who was such a distinguished and esteemed member of our Academy, and conveys its heartfelt condolence to Lady Sulaiman and her children."

Biological Abstracts.—During 1940, 605 contributions to the increasingly popular field of bioclimatology were summarized in *Biological Abstracts*. The *Bioclimatology-Biometeorology* section proper reported 234 contributions that had appeared in 127 current periodicals and reviewed 31 books. References to climate and weather effects on human physiology, animal and plant behaviour were reported in 340 abstracts in other sections of *Biological Abstracts*, and their subject-matter was outlined, month by month, at the beginning of the *Bioclimatology-Biometeorology* section.

These are the results of the first complete year of reporting research in this field.

Bombay University.—Mr. R. P. Masani has been reappointed Vice-Chancellor of the Bombay University with effect from April 1, 1941.

Aligarh University.—Sir Ziauddin Ahmad was elected Vice-Chancellor of the University at the meeting of the Court held on 20th April.

Madras University.—Mr. P. S. SRINIVASAN has been admitted to the degree of Doctor of Science, in consideration of his thesis entitled *"The Elastic Properties of Molluscan Shells and the Elastic and Thermal Properties of Timber"*.

University of Calcutta.—Mr. S. Raghavender Rao has been admitted to the Degree of Doctor of Science in consideration of his thesis entitled *"Studies on the Epidemiology of Plague"*.

MAGNETIC NOTES

The month of March 1941 was more active than the preceding month. There were 6 *quiet* days, 18 days of *slight* disturbance, 6 of *moderate* disturbance and one of *very great* disturbance as against 9 quiet days, 12 of slight disturbance, 6 of moderate disturbance, 2 of Great disturbance and 2 of very great disturbance during March of last year. The day of largest disturbance during March 1941 was the 1st and that of least disturbance the 26th. The characters for individual days are given in table below:

Quiet days	Disturbed days		
	Slight	Moderate	Very great
10, 16, 17, 24–26	3–9, 11–13, 15, 18, 20–23, 27, 29.	2, 14, 19, 28, 30, 31.	1

Three magnetic storms, 2 moderate and one of very great intensity were recorded during the month of March this year as against 3 storms (2 of great intensity and one of very great intensity) during March 1940. The mean character figure for the month of March 1941 is 1·03 as against the same figure for March of last year.

M. R. RANGASWAMI.

SEISMOLOGICAL NOTES

March 1941.—During the month of March 1941, one moderate and five slight earthquake shocks were recorded by the Colaba seismographs as against two moderate and four slight ones recorded during the same month in 1940. Details for March 1941 are given in the following table:

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of Focus	Remarks
		H.	M.	(Miles)		(Miles)	
March 1941							
12	Slight	03	19	1310			
12	Slight	19	47	4390			
13	Slight	03	07	4420			
16	Moderate	13	12	5270			
17	Slight	02	25	810	Epicentre in the neighbourhood of the Maldive Islands in the Indian Ocean		
29	Slight	02	43	1470			

ASTRONOMICAL NOTES

Planets during May 1941.—Mercury will be in conjunction with the Sun on May 6 and will afterwards pass into the evening sky; it reaches greatest elongation from the Sun on June 4. Venus is an evening star and will be visible low down in the western sky soon after sunset; it is gradually separating from the Sun and at the end of the month, its altitude at sunset will be about 11°. Mars is nearly on the meridian at sunrise and continues to increase in brightness, its stellar magnitude on May 31 being 0·1.

The three major planets, Jupiter, Saturn, and Uranus are all too close to the Sun and not favourably situated for observation. Saturn will be in conjunction with the Sun on May 9, Jupiter on May 19, and Uranus on May 17. Neptune will be on the meridian at about 8 p.m. and continues to move in a retrograde direction in the vicinity of the star β Virginis (magnitude 3·8).

The meteoric showers known as η Aquarids may be seen in the early morning hours before sunrise between May 2 and 6. They are supposed to be associated with Halley's Comet and the position of the radiant point is given by R.A. $22^h\ 32^m$ and Declination 2° South.

T. P. B.

ANNOUNCEMENTS

Kalyankumar Mukherjee Scholarship for 1941.—Applications are invited from graduates of the Calcutta University for the award of the Scholarship for the year 1941. The following subjects have been selected for investigation by the candidates.

(1) Tuberculosis as a community disease.
(2) Nutritional disease in children up to the age of two.

The successful candidate will receive a non-recurring research grant of about Rs. 750. Applications should reach the Registrar of the Calcutta University *before 30th June* 1941.

Essential Oil Industry.—On the recommendation of the Board of Scientific and Industrial Research, the Government of India have set up an exploratory committee for surveying the present position of the essential oil industry in this country. The Committee will consist of Mr. P. A. Narielwala, General Manager, Tata Oil Mills Company Limited, Bombay, (convener), and Mr. J. N. Rakshit, Chemical Examiner to the Government of India (retired).

Enquiries and suggestions made to the Director, Scientific and Industrial Research, concerning the industry and trade as well as the supply of aromatic trees, plants and grasses, will be considered by the Board and the Committee.

Testing of Materials.—With a view to afford some measure of relief in the matter of fees to nascent and undeveloped Indian industries the Government of India have decided, as an experimental measure for one year, to reduce the testing fees to a certain definite extent in cases where Government are satisfied as to the need for concession. To take advantage of this concession firms and individuals will have to apply to the Superintendent, Government Test House, preferably through the Directors of Industries of the respective provinces, substantiating their claims to such concession.

A wide variety of materials, including textile goods, electrical equipment and stores, building and general engineering materials, vacuum brake fittings, metals and alloys, minerals and ores and miscellaneous stores, such as oils, lubricants, paints, varnishes, chemicals, fuels, etc., etc., are tested in the Government Test House, to determine their qualities. The Government of India issue two "Schedules of charges" for tests and analyses—one for Government Departments and the other for private firms and individuals.

Test certificates, bearing the Government seal, which can be used by the firms and individuals for commercial purposes, are issued to all samples tested.

* * *

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4577–78.
"Journal of Agricultural Research," Vol. 61, Nos. 4–8.
"Agricultural Gazette of New South Wales," Vol. 52, Pt. 2.
"Indian Journal of Agricultural Science," Vol. 9, Pt. 1.
"Biological Reviews," Vol. 16, No. 1.
"Journal of the Indian Botanical Society," Vol. 20, No. 3.
"Journal of Chemical Physics," Vol. 9, No. 2.
"Journal of the Indian Chemical Society," Vol. 17, Nos. 11–12.
"Chemical Products," Vol. 4, Nos. 1–2.
"Indian Central Jute Committee" (Bulletin), Vol. 3, No. 12.
"Bulletin of the American Meteorological Society," Vol. 21, No. 10.
"Indian Medical Gazette," Vol. 76, No. 3.
"Journal of Nutrition," Vol. 21, No. 2.
"Nature," Vol. 146, Nos. 3713–14 and Vol. 147, No. 3715.
"Indian Journal of Physics," Vol. 14, Pt. 5.
"Canadian Journal of Research," Vol. 18, No. 11 (A.B.C.D.).
"Sky," Vol. 5, No. 5.
"Science and Culture," Vol. 6, No. 10.
"Indian Trade Journal," Vol. 140, Nos. 1812–15.

Books

Temperature, its measurements and control in science and industry. By The American Institute of Physics. (Reinhold Publishing Corporation, New York), 1941. Pp. xiv + 1362. Price $11·00.

Temperature measurement. By Robert L. Weber. (Edwards Brothers Inc., Michigan), 1941. Pp. x + 171.

Practical Histology and Embryology. By Nellie B. Eales. (Macmillan Co., London), 1940. Pp. vi + 111. Price 3*sh.* 6*d.*

The Indian Sugar Industry (1940 Annual). (Messrs. Gandhi & Co., Calcutta), 1941. Pp. 350. Price Rs. 4–8–0 or 12*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences:

(*Proceedings*)

March 1941. SECTION A.—I. D. SETH: *Reflection and refraction of attenuated waves in semi-infinite elastic solid media.* T. M. K. NEDUNGADI: *Effect of crystal orientation on the Raman effect in naphthalene and benzophenone.* From the observed changes in intensities and the known molecular orientations in the crystal, it is deduced that the incident light vector vibrating in the plane of the aromatic ring excites some oscillations of the molecules much more strongly than the light vector perpendicular to the plane. R. D. DESAI AND W. S. WARAVDEKAR: *Heterocyclic compounds. Part XII. Chromones from resacyl and gallacylphenones containing long-chain acyl groups, and some chemical properties of these hydroxy-ketones.* S. ASHRAF ALI, R. D. DESAI AND H. P. SHROFF: *Heterocyclic compounds. Part XIII. Abnormal alkaline hydrolysis of some* 4-*isopropyl*-1 : 2-*α-naphthapyrones.* T. A. S. BALAKRISHNAN: *An elementary theory of the coronas of water droplets.* The water droplets are treated instead of as opaque discs as perfectly transparent spheres in passing through which the wave fronts undergo a phase retardation. K. NEELAKANTAM AND L. RAMACHANDRA ROW: *The lanthanum nitrate test for acetate in inorganic qualitative analysis.* The above test for acetate ion has been examined for use in the routine analysis for mixtures of inorganic substances including the acetate, oxalate, and tartrate radicles. V. SUBBA RAO AND T. R. SESHADRI: *Chemical investigation of Indian lichens. Part III. The isolation of montagnetol, a new phenolic compound from* Roccella montagnei. MOHAMMAD SHABBAR: *On the existence of a metric for path spaces admitting the lorentz group.* S. V. ANANTHAKRISHNAN AND V. PASUPATI: *Substitution in polycyclic systems. Part II. The nitroderivatives of fluoryl* 9-*trimethylammonium compounds.* P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *A study of the chemical components of the roots of* Decalepis Hamiltonii (*Makali Veru*). *Part I. Chemical composition of the roots.* K. V. BOKIL AND K. S. NARGUND: *Synthesis in the chaulmoogric acid series. Part III. Synthesis of* dl-*hydnocarpic acid.* Synthesis of *dl*-hydnocarpic acid has been effected for the first time and described. V. V. NARLIKAR: *A classical limit of heavy homogeneous spherical masses.* TRIPURA CHARAN SARKAR: *The lead ratio of a crystal of monazite from the Gaya District, Bihar.* The pegmatites of Gaya may be considered as the last phase of igneous activity in post-Dharwar and pre-Cuddapah times.

SECTION B.—P. N. GANAPATI: *On a new myxosporidian* Henneguya otolithi *N. Sp. A tissue parasite from the bulbus arteriosus of two species of fish of the genus* Otolithus. L. S. S. KUMAR AND S. SOLOMON: *A list of hosts of some phanerogamic root-parasites attacking economic crops in India.* G. N. RANGASWAMY AYYANGAR AND B. W. X. PONNAIYA: *Studies in* Sorghum halepense (*Linn.*) *Pers—the Johnson grass.* M. A. BASIR: *Two new nematodes from an aquatic beetle.* L. S. S. KUMAR AND G. B. DEODIKAR: Commelina alisagarensis *Kumar and Deodikar: a new species from Hyderabad, Deccan, India.* SYED MUZAMMIL ALI: *Studies on the comparative anatomy of the tail in sauria and rhynchocephalia. I.* Sphenodon punctatus *Gray.* K. H. ALIKUNHI: *On a new species of* praegeria *occurring in the sandy beach, Madras.*

Indian Chemical Society: (*Journal*)

November 1940.—PHANINDRA CHANDRA DUTTA: *Studies in the Sesquiterpene Series. Part I. Synthesis of the Triethyl Esters of* $C_{11}H_{15}(CO_2H)_3$, *obtained from Selinenes.* G. S. KASBEKAR: *Vapour Pressures of Aqueous Solutions.* SANTI RANJAN PALIT: *Physical Chemistry of Resin Solutions. Part III. Viscosity of Shellac Solutions in Mixed Solvent.* N. R. DHAR, A. K. BHATTACHARYA AND S. P. AGARWAL: *Chemical Reactivity and Light Absorption. Part IV.* PRIYADARANJAN RAY: *Estimation of Zinc in Snake Venoms by Micro-quinaldinate Method.* KESHO DASS JAIN AND J. B. JHA: *Adsorption of Mono- and Polybasic Acids by Sugar Charcoal.*

Indian Botanical Society: (*Journal*)

February 1941.—B. SAHNI: *Palæobotany in India. II. Progress Report for 1940.* T. EKAMBARAM AND MISS V. K. KAMALAM: *Studies in absorption and transpiration. III. Effects of hypertonic solutions on leaf turgidity.* MISS V. K. KAMALAM: *Studies in absorption and transpiration. Part IV. The effect of oxygen concentrations on absorption of water and transpiration.* A. C. JOSHI AND J. V. PANTULU: *A morphological and cytological study of* Polianthes tuberosa *Linn.* M. O. P. IYENGAR AND MISS B. VIMALA BAI: *Desmids from Kodaikanal, South India.* M. O. P. IYENGAR AND S. KANTHAMMA: *A note on* heterothrichopsis viridis *gen. et sp. nov.*

March 1941.—M. J. THIRUMALACHAR: *Tuberculina on* Uromyces Hobsoni *Vize.* N. KRISHNASWAMI AND G. N. RANGASWAMI AYYANGAR: *Chromosomal alterations induced by X-rays in Bajri* (Pennisetum typhoides *Stapf & Hubbard*). GIRIJA P. MAJUMDAR: *Anomalous structure of the stem of* Nyctanthes arbortristis *L.* K. RANGASAMI: *A morphological study of the flower of* Blyxa echinosperma *Hook.* F. SULTAN AHMAD: *Higher fungi of the Panjab plains. III. The gasteromycetes.* M. O. P. IYENGAR AND K. R. RAMANATHAN: *On the life-history and cytology of* Microdictyon tenuius (*Ag.*) *Decsne.*

Imperial Institute of Sugar Technology, Cawnpore: (*Scientific Reports*)

The recent publication (I.C.A.R. 24.38/350) by the Imperial Council of Agricultural Research, of the Scientific Reports of the Imperial Institute of Sugar Technology, India, Cawnpore, covers the period, 1st October 1936 to 31st March 1939. This consists of two parts, being the reports of the Director of the Institute and of the different sectional heads. This is the first report of the Institute after its establishment in October 1936 and covers the varied activities of the Institute in carrying out research work on problems of imminent interest to the Indian Sugar Industry and in rendering technical help to several factories when called for. The reports are of great interest to sugar technologists and industrialists.

Royal Asiatic Society of Bengal

April 7, 1941.—CHRISTOPH VON FURER-HAIMENDORF: *Seasonal Nomadism and Economics of the Chenchus of Hyderabad.* W. J. CULSHAW: *Some beliefs and customs relating to birth among the Santals.* S. L. HORA AND J. C. GUPTA: *Fish from Kalimpong Duars and Silguri Terai, North Bengal.* Notes on the physical conditions of the parts of the Kalimpong Duars and of the Siliguri Terai in which collections were made are given. "A list of 58 species is given and additions and alterations made in a list of 131 species of fish of Northern Bengal published by Messrs. Shaw and Shebbeare in 1938 are explained. Taxonomic notes were given on *Lepidocephalus guntea* (Hamilton), *Semiplotus semiplotus* (McClelland) and *Barbus* (*Puntius*) *titius* Hamilton."

Meteorological Office Colloquium, Poona:

February 18, 1941.—DR. R. ANANTHAKRISHNAN: *Recent work on the reflection of radio waves from temperature discontinuities in the troposphere.*

February 25, 1941.—DR. L. A. RAMADAS: *Studies on the movements of free particles and light objects when placed in a thermal gradient.*

Erratum

Vol. 10, *No.* 3, *March* 1941: P. 173, Note on "Chromatin Bridges in the Root Tip of Groundnut", *insert* the following under Fig. 1: "The fragment found along with the chromatin bridge".

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CURRENT SCIENCE

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SIR P. C. RAY

IN order to commemorate the eightieth birthday of Sir P. C. Ray an appeal has been issued by eminent Indians belonging to all walks of life for a fund, which would be associated with his name and utilised for the promotion of scientific and industrial research. The appeal, which we are publishing elsewhere, recalls what the Indian nation owes to Sir P. C. Ray and we would on this happy occasion like to dwell briefly on his truly eventful life.

Born on August 2, 1861, in a village called Raruli in Bengal, Prafulla Chandra was nurtured in a cultured family and brought up for a few years on the country estate of his father, Haris Chandra Ray. In 1870, the family moved to Calcutta, and Prafulla Chandra received his early education at the well-known Hare School, and later at the Metropolitan College founded by the illustrious Iswar Chandra Vidyasagar. A Gilchrist Scholarship, which he won in a competitive examination, enabled him to proceed abroad in 1882 and work for his B.Sc. and D.Sc. degrees of Edinburgh University under Prof. Crum Brown. He secured the Hope Prize Scholarship, acted as a member of the staff and was also elected Vice-President of the University Chemical Society, of which Crum Brown was the President. Prominent among his fellow-students was James Walker, who later distinguished himself as a physical chemist. One striking event which throws considerable light on the burning patriotism and on the versatile talents of Prafulla Chandra was when he wrote his famous essay on India while still a student at Edinburgh. This, as is well known, brought the young Indian student a highly appreciative letter from John Bright, part of which was as follows: "There is an ignorance on

the part of the public in this country and great selfishness here and in India as to our true interests in India. The departures from morality and true statesmanship will bring about calamity and perhaps ruin, which our children may witness and deplore." It looks as if this might have been written yesterday!

Returning to India, Prafulla Chandra Ray joined Presidency College as an assistant professor in 1889 and found that Imperial Services were not meant for Indians, however talented they might be. His enthusiasm for research was, however, unbounded and it was at Presidency College that he began to infect his students with his enthusiasm for chemistry. He has been directly and indirectly the creator of that flourishing school of chemistry that we see in India to-day. Most of his later work was carried out at the University College of Science and Technology, which owes its origin to the genius of Sir Asutosh Mookerjee and the munificence of Sir Taraknath Palit and Sir Rashbehary Ghose. At the invitation of Sir Asutosh, Sir P. C. Ray joined the Palit Chair of Chemistry in 1916, which he held till a few years back. His scientific work has embraced varied fields in inorganic and organic chemistry and his monumental work on the "History of Hindu Chemistry" brought him a great tribute from that world-renowned savant Berthelot. The founding of the Indian Chemical Society was one of the products of his life-long scientific labour.

What is, however, noticeable in the career of Prafulla Chandra is a passionate love for India and his anxiety to make India modern, scientifically minded and industrialised. It is this urge that led him to his pioneering effort in founding the Bengal Chemical and Pharmaceutical Works, Ltd. Although Sir P. C. Ray has not only founded this firm but has helped its progress in every conceivable way, it is common knowledge that he himself refused to derive any financial benefit from it. It is up to this firm now to redeem its debt by contributing liberally to the fund for which the appeal has been issued.

As a philanthropist and a man whose heart goes out to his fellow-countrymen in every distress, Sir P. C. Ray needs no praise. His colossal efforts during the North Bengal Flood, his literally spending himself in order to help poor students and in order to support various organisations for social uplift are well known. In fact, when one reflects on the life of Sir P. C. Ray, one would find it difficult to find a parallel embodying in one personality his utter selflessness bordering on asceticism, his passionate devotion to science and learning in varied branches, his consuming love for his country and for the lowly and the poor, and his almost evangelical efforts to get this country out of the rut of obscurantism and superstition and put it on the road of science and industry. There is indeed hardly any aspect of India's national renaissance that does not bear the indelible impress of Sir P. C. Ray's leadership and untiring work. It is a matter of pride for any nation to be able to honour such a man and we would heartily endorse the appeal which seeks to perpetuate his eightieth birthday by raising funds for the promotion of scientific and industrial research, which has been the central love of his life.

THE QUANTUM THEORY OF X-RAY REFLECTION

BY

SIR C. V. RAMAN AND DR. P. NILAKANTAN

IN an article in *Current Science* for April 1940 under the title of "A New X-ray Effect", we drew attention to the remarkable features noticeable in a strongly exposed Laue diagram obtained with a cleavage plate of diamond when the X-ray pencil from a copper-target tube passes through the crystal approximately along the trigonal axis. Having convinced ourselves that the features we observed and described lay outside the scope of the classical X-ray optics, we put forward an explanation of the phenomena on novel lines. Basing ourselves on the accepted principles of the quantum theory of radiation, we showed that the lattice planes in a crystal should be capable of giving two kinds of geometric reflection of X-rays; besides the classical or Laue reflections, modified or quantum reflections are also possible which have their origin in the *quantum-mechanical* excitation of the *optical* vibrations of the crystal lattice. The geometric law of the quantum reflection stands in the same relation to the dynamic stratifications of electron density associated with such vibrations of the lattice that the classical reflections have in relation to the static structure amplitudes of the crystal. The investigations we have made during the past twelve months have completely confirmed the views expressed by us in the article referred to. It is our purpose in the present communication to indicate how such confirmation has been reached, and briefly to present the new ideas regarding the dynamics of crystal vibrations of the optical class to which we have been led by our X-ray studies.

The nearest approach to our point of view to be found in the classical literature is a memoir by Laue in the *Annalen Der Physik* for December 1926, in which he subjects the work of Debye, Faxen and Waller on the problem of the scattering of X-rays in crystals to a critical review and treats it afresh on original lines. Laue explicitly restricts himself to those modes of vibration of the crystal lattice which do not involve relative displacements of the atoms in the unit cell, in other words, to the elastic modes of vibration. His most striking result is that the scattering of X-rays occurs in every case with a change of frequency equal to that of the mechanical vibration of the crystal. He further shows that for elastic vibrations of any specified wave-length and orientation to be effective, the usual Laue conditions must be satisfied with respect to a spacing found by a vectorial combination of the reciprocals of a given lattice spacing and the given wave-length. Laue's investigation thus indicates, in the language of the quantum theory, that the scattering of X-rays by the elastic waves also involves an exchange of momentum and energy between the photon and the crystal. The geometric conditions for such scattering are formally analogous to those for a dynamic reflection. But fundamental differences between the cases of the acoustic and the optical vibrations of the crystal lattice emerge as soon we enter into a closer consideration of the problem.

At a very early stage of our investigations, we considered the question whether the modified reflections observed by us in diamond and other crystals could possibly be explained in terms of the thermal scattering of X-rays by the elastic waves, and came to the conclusion that this was quite impossible. Indeed, Laue himself remarks towards the end of his paper that no noticeable concentrations of intensity in any direction could be expected as the result of X-ray scattering. As some X-ray workers (Lonsdale, Zachariasen) have expressed a different opinion in the recent literature of the subject, it would appear worthwhile to explain why it cannot be correct. The essential feature of the acoustical vibrations of the lattice is that the waves have all possible lengths and orientations, subject to the restriction that the total number of such waves is 3 N, N being the number of lattice cells in the crystal. This restriction is automatically secured when, following Born, we set out the reciprocals of the wave-vector in a three-dimensional space. The reciprocal points then appear uniformly distributed in the "phase-space". Actually, when the finite resolving-power of the crystal considered as an optical grating is taken into account, these discrete points are "smudged"

out just sufficiently to make the "phase-space" just a uniform continuum within which the terminus of the reciprocal wave-vector must lie. It is obvious that in these circumstances, the scattering of the X-rays cannot give rise to any phenomenon even distantly approaching the character of a geometrical reflection. Further, the intensity of the scattering in any specified direction being proportional to N, its intensity would be quite negligible in relation to the intensity of the classical reflection which is proportional to N^2, provided the volume of the irradiated crystal is sufficiently small. In actual experience, however, the modified reflections by the (111) planes in diamond continue to be recorded even when the volume scattering by the crystal is made negligibly small by using a fine X-ray pencil and the edge of a thin plate to obtain the reflection.

The considerations stated are sufficient to show that the observed effects are not due to X-ray "scattering". It is worthwhile, however, to go rather more deeply into the matter. The believers in the "scattering" theory place their reliance on the fact that the expression for its intensity contains a factor proportional to the square of the wave-length of the elastic waves. This factor undoubtedly becomes important when the elastic wave-lengths are great. But it is just at this stage that the scattering coincides in direction with a classical reflection and is therefore wholly unobservable. When the crystal setting is altered even by a degree of arc, the numerical factor ceases to be important, and instead of a "peak" the theory indicates only a "hump" in the scattering intensity curve which becomes rapidly less pronounced as the crystal is moved away from the correct setting for a monochromatic reflection. The actual experimental observations with the (111) reflections of diamond reveal a very different state of affairs. As can be seen from Fig. 1, the modified reflections persist with undiminished sharpness over a wide range of settings of the crystal.

A crucial test of the whole question is furnished by our low-temperature experiments with diamond. As already mentioned, a change of frequency, in other words, a transition between the different energy levels in the crystal is involved in either case. On the "scattering" theory, we are dealing with elastic waves of relatively great wave-length and low frequency. Indeed, the nearer the direction of scattering is to that of the classical reflection, the longer would be the effective wave-length and the lower the frequency of the

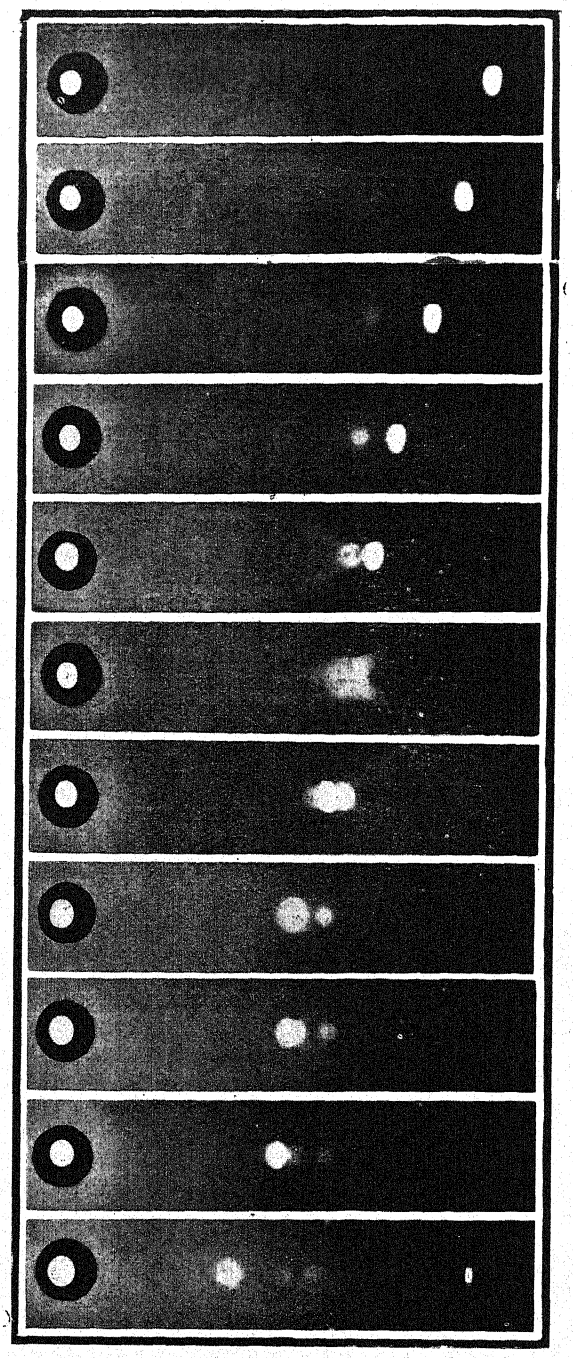

FIG. 1. The Modified Reflection by the (111) planes of a diamond crystal at various settings with copper $K\alpha$ and $K\beta$ X-rays

vibrations. Transitions between such low frequency levels are necessarily determined with all desirable accuracy by the classical dynamics. In other words, the intensity of the X-ray scattering should diminish in proportion to the absolute temperature. The case of diamond is specially suitable for such a test, because in respect of elastic waves of the length effective at small angles of scattering, $h\nu^* \ll kT$, while for the optical vibrations $h\nu^* \gg kT$. The necessary experimental tests have been tried out by us and fully confirm the prediction published in May 1940. They show that the modified reflections by the (111) planes in diamond appear with sensibly unaltered intensity when the crystal is cooled down to liquid air temperature, and that is the case, irrespective of the crystal setting employed. The observations clearly indicate that $h\nu^* \gg kT$, in other words, that the modified reflections are due to the *optical* vibrations of the lattice, and not the acoustic ones. They also demonstrate that the modified reflection is a quantum-mechanical effect.

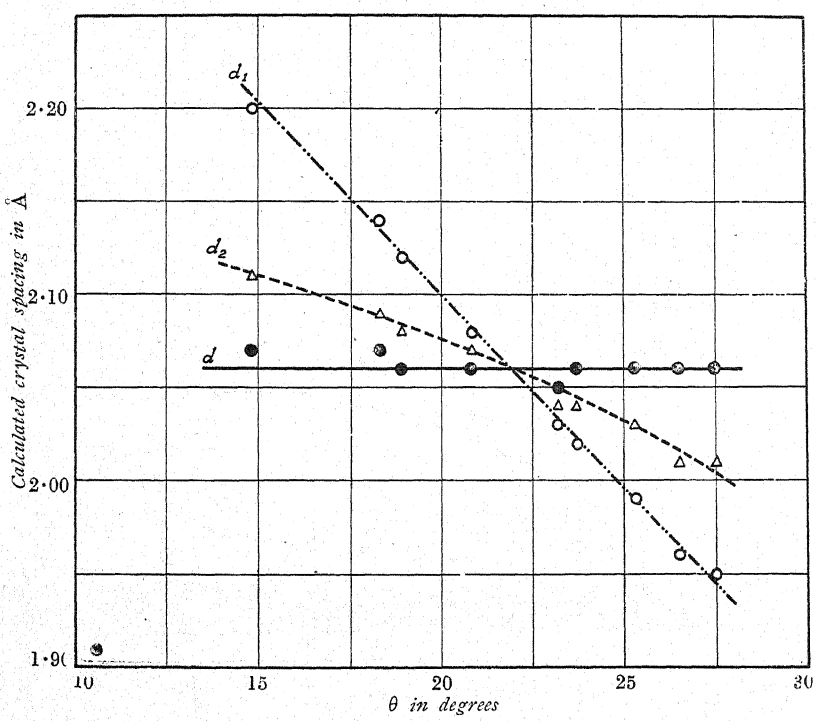

FIG. 2

Showing the failure of the Faxen formula for the (111) reflections by diamond

While the elastic vibrations of the lattice correspond to the three translatory movements of the lattice cells, the optical vibrations represent all the remaining degrees of freedom of atomic movement, and are best regarded as oscillations of the interpenetrating lattices in the crystal with respect to one another. In all actual crystals, the number of such possible vibrations is comparable with and indeed in many crystals very much greater than the number of the acoustic degrees of freedom. As is very clearly shown by spectroscopic studies of light scattering in crystals, these optical vibrations may often be of quite low frequency and are therefore powerfully excited by the thermal agitation of the crystal. Even considered from the purely classical point of view, therefore, the optical vibrations of the lattice must play an extremely important part in X-ray optics. There is ample evidence that this is actually the case and that the modified reflection of X-rays is directly associated with such optical vibrations. To mention only one instance, we may refer to our published results on the special behaviour of the classical and modified reflections by the (210) planes in sodium nitrate and their relation to the thermal excitation of the rotational oscillations of the NO_3 ions in the crystal.

An oscillation of the interpenetrating lattices in the crystal with reference to one another alters the structure amplitudes of the unit cells without appreciably displacing them from their positions in the ordered arrangement of the crystal. Such oscillation is therefore capable of giving rise to geometric reflections by the crystal planes with an intensity proportional to N^2 and to the square of the periodic variation of structure amplitude produced by such oscillation. Since the atomic vibrations in the different cells are of identical frequency and are mechanically coupled to each other, they are necessarily in coherent phase-relationship with

each other. It is readily shown that for a modified reflection to be observable in any specified direction, the usual Laue condition must be satisfied by the dynamic spacing obtained by a vectorial combination of the reciprocals of the crystal spacing and of the phase wave-length of the optical oscillations in the crystal. To find the directions in which the modified reflections appear, we proceed to set out the reciprocal wave-vectors for the particular optical vibration in a three-dimensional diagram. It is at this point that the fundamental difference between the acoustical and optical modes of the vibration of the lattice emerges. As we have already seen, such a diagram for the elastic waves is effectively a continuum which is everywhere of uniform density. If this were also true for the diagram in the optical case, there would be no possibility of explaining the actually observed reflections. We are obliged therefore to conclude that *the Born diagram correctly represents only the acoustic "phase-space" and has no application or significance with respect to the optical "phase-space".*

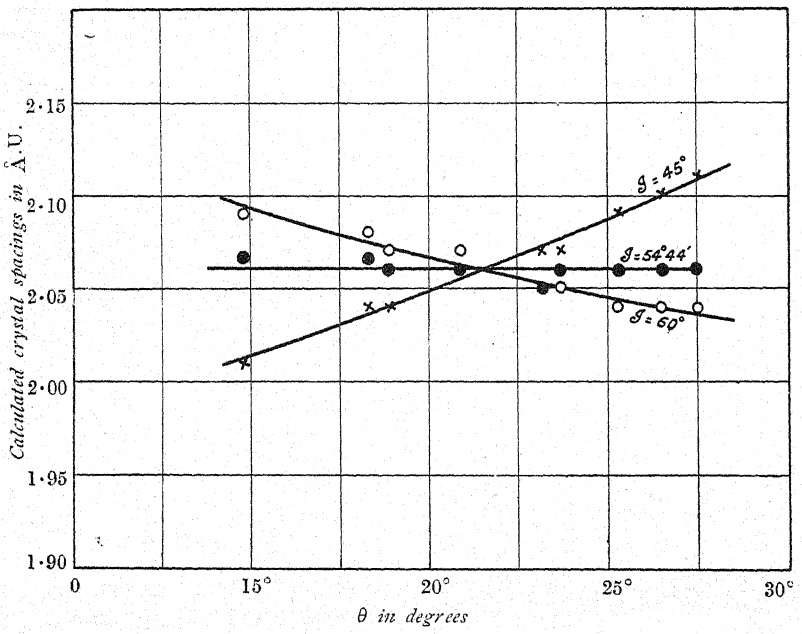

FIG. 3

Determination of the Inclination of Phase-Waves to the (111) Crystal Spacings in Diamond

The conclusion stated above cannot be regarded as in any way incredible or even surprising. The Born method of enumerating the oscillations of the lattice is purely geometrical in spirit and is essentially only a refinement of the well-known Rayleigh-Jeans method, and its physical content must therefore be the same. In other words, its validity is restricted to the enumeration of the acoustic vibrations. The optical vibrations of the lattice, on the other hand, may be regarded as analogous to the specific vibrations of a molecule of giant size, and there is no logical reason that one can discover for assuming that the reciprocal phase wave-lengths for the oscillations of such a molecule when represented geometrically should fill space with uniform density. On the contrary, it is reasonable to assume that the possible orientations of the phase-waves are of a highly restricted character and have a specific relation to the symmetry characters of the crystal and of the particular mode of vibration involved. Accepting this idea, we realise immediately that intense and highly localised modified X-ray reflections become possible when oscillations with such a character are excited.

A convincing proof of the correctness of the ideas above set forward is furnished by a quantitative study of the (111) modified reflections of diamond for various orientations of the crystal, the plane of incidence coinciding with a plane of symmetry. A full account of the work will appear shortly in the *Proceedings of the Indian Academy of Sciences*. It will be sufficient here to refer to the results shown graphically in Figs. 2 and 3. In Fig. 2, the actually observed angular positions of the reflections are represented against the crystal spacings as calculated from three different formulæ. The graph marked d_1 assumes that the phase-waves are normal to the static crystal-spacing. The graph marked d_2 is a curved

line which represents the crystal spacing calculated from the Faxen formula. The graph marked d is calculated on the assumption that the phase-waves, are inclined to the (111) planes at a constant angle of 54° 44′ which is half the tetrahedral valence angle, in other words parallel to the (100) planes transverse to the plane of incidence. It will be seen from the figure that the third graph is a horizontal straight line and gives a constant spacing very close to the actual one, namely 2·055 A.U.

In order to exhibit how closely the observed inclination of the phase-waves may be determined from the observed data, Fig. 2 shows the crystal spacing worked out for three different values of the angle, namely 45°, 54° 44′ and 60°. It is evident that if the graph is to be a horizontal line, the angle cannot differ from half the tetrahedral valence angle by more than 1° either way. It is thus clear that the Faxen formula is wholly irrelevant to the present problem and that the modified reflections arise from the fact that the phase-waves of the optical vibration have a precisely determined orientation and azimuth with reference to the crystal planes. Further striking confirmation of these conclusions is afforded by the observations of fainter reflections by the phase-waves parallel to the two other (100) planes inclined to the plane of incidence, and by the effect of inclining the plane of incidence to the plane of symmetry. Into these details we need not here enter.

THE SULPHUR POSITION IN INDIA

BY

SIR S. S. BHATNAGAR, Kt., O.B.E., D.Sc., F.Inst.P., F.I.C.

IT is not necessary to enumerate the numerous uses of sulphur. Sulphur and sulphuric acid are indispensable to any country not only for the production of war-time requirements, but also for the needs of all important industries even during peace-time.

It is well known that all sulphur used in India and Burma is imported. Essential supplies cannot be obtained from within the Empire. The quantities in tons of sulphur imported during recent years and the sources from which the supplies were obtained are shown in the following table:

It is obvious from the table that the principal importing countries before the outbreak of war were Italy, Japan, Java and the United States of America.

The rapidity with which the European conflagration is spreading and the threats of war from our eastern neighbours have brought the sulphur problem in India to the forefront and both the Government and the public outside have studied the subject with more than usual enthusiasm and concern. In the second meeting of the Board of Scientific and Industrial Research held in Simla on the 12th and 13th June 1940,

	1933–34	1934–35	1935–36	1936–37	1937–38 (Excluding Burma)
British Empire	69	89	29	55	145
Germany	1,604	492	2,108	918	177
Italy	12,258	10,680	9,226	9,472	18,363
Java	2,091	2,448	1,643	1,837	991
Japan	4,856	5,945	12,376	11,742	9,221
U.S.A.	1,286	541	591	1,729	380
Other countries	10	53	25	1,780	131
Total all countries	22,174	20,221	2[illegible],993	27,539	29,408

Note.—The estimated value of the 29,408 tons imported in 1937–38 was Rs. 25,95,206 or approximately Rs. 90 per ton. The present price is approximately Rs. 150 per ton.

Brigadier Wood of the Supply Department emphasised the fact that the most important material which constituted a real shortage from the point of view of supplies was sulphur and the Board decided to constitute the following committee to study the sulphur problem in India from all points of view:

Sulphur Committee.—S. S. Bhatnagar (*Chairman*), Cyril S. Fox, J. C. Ghosh and H. Krall (subsequently added on Chairman's recommendation).

In the earlier stages, the Committee examined the sulphur question from the following points of view:

(1) From the view-point of existing methods of the recovery of sulphur from sulphur-bearing salts and minerals available in abundance in this country.

(2) From the view-point that the described and the talked of, but probably available sources of natural sulphur and sulphur-bearing minerals, may be examined again with a view to seeing if the likely supplies are expected to be larger than previously estimated. and

(3) From the point of view of manufacturing or extracting sulphur compounds useful in trade from natural sources such as coal, oil, etc., which have been reported to be sufficiently rich in sulphur content.

As the functions of the Board of Scientific and Industrial Research are to finance those investigations which may lead to some tangible practical results by research, all items under (1) were to be examined from the economic point of view only, but attention was to be particularly bestowed upon (2) and (3) which required research.

As regards (1), particular attention was given to the subject of the recovery of sulphur from coke-oven gases, smelter gases such as those of the Indian Copper Corporation and the Burma Corporation and the utilisation of the deposits of gypsum for the production of sulphur. Various processes have been worked out in industrial countries to carry out one or other of these operations and particular mention has been made in this connection of the "Thylox" process, the "I.C.I./Bolidens" process, the "Orkla" process and others.

Thylox Process.—This process has been developed from the non-recovery Seaboard Process in Germany and the United States where it is widely employed for the treatment of domestic gas supplies for the removal of hydrogen sulphide and recovery of sulphur from coke-oven gases. In this process the hydrogen sulphide is removed by scrubbing the gas with an absorbing solution consisting of certain alkali metal compounds of arsenic, such as sodium or ammonium thioarsenate and is recovered to sulphur on oxidation by air. These reactions are fairly represented by the following equation:

$$Na_3AsO_2S_2 + H_2S = Na_3AsOS_3 + H_2O$$
$$Na_3AsOS_3 + O = Na_3AsO_2S_2 + S.$$

The solution remains uncontaminated by other substances in the gases both during treatment of the gas and also during regeneration of the foul solution. As a result, the sulphur filtered from the solution is not contaminated by other substances and is so pure that it can be sold both as sulphur and as an agricultural fungicide.

The Thylox process, or one or other of its alternative developments, such as the Ferrox, Nickel, Phosphate, and Phenolate processes, is now in general use for the removal and recovery of sulphur from various kinds of fuel gases, including coke-oven gas, blue-water gas, carburetted water gas, and oil refinery gases. These processes are best adapted to dealing with fuel gases at ordinary pressure which contain small or moderate quantities of hydrogen sulphide. The newest type of Thylox plant consists of a tower absorber, through which the gases pass and are scrubbed during transit by means of the solution, an aerating tower in which the foul solution is aerated thereby effecting liberation and flotation of the sulphur, a sulphur slurry tank, and a continuous filter for the removal of the sulphur. The whole plant occupies very little ground space. A heater or other means of warming the solution is unusually provided so as to heat the solution entering the aerating tower up to about 95° F., which is the best temperature for effecting the oxidation reaction. About 98 per cent. of the hydrogen sulphide content of the gas can be removed by this process. Pointed attention of the Tata Iron and Steel Company, Jamshedpur, was drawn to the advantage which would accrue if they adopted this process, and they promised to consider the whole question.

I.C.I./Bolidens Method.—A company named Messrs. Sulphur Patents Ltd., London, was formed within recent years by Messrs.

Imperial Chemical Industries Ltd., and a Swedish firm, Messrs. Boildens Gruvaktiebolag, for the recovery of sulphur from smelter gases produced when smelting ores similar to those occurring in India and Burma. The Swedish firm had developed a process for the direct production of sulphur from smelter gases and had operated a plant for several years at their mine in Sweden with a production capacity of up to 70 tons of sulphur per day. During the same period Messrs. Imperial Chemical Industries had developed a process for the production of concentrated sulphur dioxide from weak gas by using an absorbing solution of basic aluminium sulphate. In view of the complementary nature of these processes, an agreement was arrived at in 1936 whereby the patents and processes of the two companies were pooled and the company under the name of Messrs. Sulphur Patents Ltd., was formed to act as sole agents to negotiate licenses for the processes owned by the two companies.

About the same time Messrs. Chemische Industries, Basle (Ciba), had also devised a process for concentrating sulphur dioxide, and this firm entered into an agreement with the Metallgesellschaft of Frankfurt, under which this process was to be developed, and Messrs. Lurgi Chemie (a wholly owned subsidiary of Metallgesellschaft) worked out a process for the production of sulphur from such concentrated sulphur dioxide. For some time these two groups, *viz.*, I.C.I./Bolidens and Lurgi/Ciba worked in competition in regard to developments in the field of concentration of SO_2 and its reduction to sulphur. Subsequently, however, the four companies pooled their patents and processes, with the result that the best process or combination of processes could be applied to each particular problem. In view of the fact that the Lurgi Chemie was a company whose specific object was the design and construction of chemical plants, the members of the pool agreed that the exploitation of the patents and processes should be placed in the hands of Lurgi Gasellschaft fur Chemie und Huttenwesen, m.b.H., Lurgihaus, Gervinusstr 17/19, Frankfurt A.M., Germany.

A branch of this firm, the American Lurgi Corporation, New York, is operating in America, but it may be assumed that Messrs. Sulphur Patents Ltd., have taken over activities connected with these developments.

Negotiations were conducted some time ago between Messrs. The Indian Copper Corporation and Messrs. Sulphur Products Ltd., with a view to investigating the economic possibilities of recovering sulphur from their smelter gases, as it was anticipated that if only a 50 per cent. yield were obtained, about 3,500 tons of sulphur might be available annually from the Singhbaum plant. These negotiations were unsuccessful, however, owing, it is understood, to the Corporation being doubtful whether the gases obtained in their present process of production could be economically utilised and also to their not being disposed to incur the considerable expenses which would be involved in installing the necessary plant. The position was examined recently once again, but the costs and patent positions are prohibitive.

It may be mentioned in this connection that the tonnage of raw material with which the Burma corporation deals is much greater than that treated by the Indian Copper Corporation, but smelting operations, with the exception of lead and silver, have not hitherto been carried so far as the extraction of the metals. Copper and nickel ores received a preliminary concentration to a matte (mainly the sulphides) and speiss (largely arsenides) respectively by means of smelting, and the matte and speiss were subsequently shipped to Germany where the extraction of the metals was carried out. Zinc sulphide was concentrated by ore dressing methods, the "concentrates" being then shipped to Belgium for smelting.

A large amount of sulphur dioxide is produced in the course of these operations and it might be quite feasible to recover sulphur from this and the Burmese Government may well direct their attention to the recovery of sulphur from these gases.

Reference has been made above to the utilisation of gypsum for the production of sulphur. The best known method of recovering sulphur or sulphuric acid from gypsum which has been developed commercially consists in their production from a sintered mixture of powdered gypsum (calcium sulphate) clay, and coal or coke. A process based on this method is operated by the Bayer organisation at Lever Kusen, Cologne, and more recently by Messrs. Imperial Chemical Industries Ltd., at Billingham, Yorkshire.

The process adopted by the former firm

consists in heating a mixture of powdered anhydride or waste calcium sulphate with powdered coal or coke and shales or clay at 800° in a rotary kiln in an oxidising atmosphere. The kilns are 164 ft. long by 10 ft. diameter and are fired by means of pulverised coal. The burner end is cooled by water drips. The object of the oxidising atmosphere is to prevent the formation of carbon oxysulphide in the gases and of calcium sulphide in the clinker. The gases, which contain 6–7 per cent. SO_2, are freed from dust by electrical deposition, washed, and sent to the chamber or contact plant. The kiln residue is ground up with blast furnace slag and marketed as cement. A description of this process is given in the *Journal of the Society of Chemical Industry*, 1920.

A similar process is used by Messrs. Imperial Chemical Industries at Billingham. Here a dry mixture of 80 per cent. anhydride, 7 per cent. coke and 13 per cent. clay is crushed and passed through tube mills. From the tube mills the raw meals is taken to blending hoppers and then to a rotary kiln similar to the usual type of cement kiln. The kiln process results in the production of clinker and gases.

From the clinker cement is produced, and the gases are passed through an electric precipitation plant of Lodge-Cottroll type and then through scrubbing towers. From the scrubbing towers the gases pass on to a sulphuric acid contact plant where 100 per cent. strength sulphuric acid is produced. Two tons of raw meal produce one ton of clinker and one ton of 100 per cent. acid. The production of the plant at Billingham was, prior to the war, 60,000 tons of 100 per cent. acid annually.

It is clear, however, that sulphur production would be of greater industrial assistance to India than sulphuric acid manufacture. To utilise this process for the production of sulphur instead of sulphuric acid would entail that the kiln gases containing sulphur dioxide, instead of being treated in a chamber or contact plant to produce sulphuric acid, would be treated according to the pooled patents and developments which were being exploited by Lurgi Gasellschaft fur Chemie und Huttenwesen m.b.H and which are now presumably being worked by Messrs. Sulphur Patents Ltd., as described above.

The economics of the process depend greatly on the price obtained for the cement produced from the clinker and this aspect of the matter is of special importance in regard to India, as there is already a large well-established cement industry in the country with surplus manufacturing plant capacity. Schemes of this type based on the existing or suitably modified processes are being examined by the Associated Cement Company and the Mysore Cement Works. It must, however, be remembered that the cost of a pilot plant for this will be in the neighbourhood of Rs. 20 to 30 thousand and if these experiments prove successful as they no doubt will, the plant itself will cost anything from Rs. 20 to 30 lakhs subject to the patent position and a certain well-known firm would be willing to instal this equipment if the Government is willing to give certain guarantees regarding the purchase of the product now, as well as, after the war, and the matter is, I believe, engaging the attention of the Government.

The Orkla Process.—This process has been developed by Messrs. The Orkla Gurbeaktiebolag of Norway for the production of sulphur from pyrites. In 1927 a 40-ton plant was erected by the firm at their Lokken mine and subsequently in 1931 a much larger plant was erected at Thamshavn on the Orkdal Fjord, having an annual capacity of 200,000 tons of sulphur. The process has now been developed successfully to yield from 85 to 90 per cent. of the sulphur, and the copper in the ore can be obtained at an economical cost. The process consists in first smelting the pyrites in a blast furnace with quartz and limestone and slagging a large part of the iron content of the ore, the copper and other metals of value being collected in the first matte. It is understood that in this smelting operation an excess of coke and a minimum supply of ore are used. The furnace gases contain sulphur vapour, sulphur dioxide and carbon disulphide. With the aid of suitable catalysts (iron and aluminium oxides have been proposed) the constituents of the gas mixture at a temperature of 350/400° C. are caused to react. Carbon dioxide and elemental sulphur are formed, the latter being thereafter solidified by condensation.

Pyrites.—Several methods have been examined and developed for the manufacture of sulphur from pyrites. In the laboratories of the Director of Scientific and

Industrial Research at Calcutta, Mr. J. N. Sarkar has investigated the possibility of making sulphur by the interaction of sulphur dioxide obtained by burning the iron pyrites and sulphuretted hydrogen obtained by the action of lime, coal dust and steam on heated pyrites. Several catalysts have been tried and the process has yielded fairly satisfactory results and a pilot plant is under construction.

The Orkla process was developed particularly to utilise iron pyrites. Now that several new deposits of pyrites have been recently reported by the Geological Survey of India and the quantity available seems to be ample, the above processes have acquired special significance.

Pure pyrites contains 46·6 per cent. of iron and 53·4 per cent. of sulphur. It burns when heated in air or oxygen and produces sulphur dioxide. It is, however, more difficult to ignite pyrites than sulphur. Ores marketed for the manufacture of sulphuric acid usually contain from 42 to 47 per cent. of sulphur, but material containing as little as 30 per cent. of sulphur can be successfully burnt. On account of the cost of transporting and handling the large proportion of inert material in pyrites, however, the material used for acid making should be as high in sulphur as possible, as the value of the pyrites to the manufacturer of sulphuric acid depends almost entirely on the sulphur content and only to a small extent on the nature and amount of the impurities in the ore. It is also important that the pyrites used for this purpose shall be equally as free as sulphur from injurious components such as arsenic, chlorine, fluorine, antimony, selenium and telerium.

Because of its considerable content of inert material, pyrites cannot be readily substituted for raw sulphur and burnt in sulphur burners. Owing to the considerable production of cinder and burnt ore when using this material, pyrites burners require to be provided with special grates and facilities for removal of the clinker and burnt ore, and in this respect they differ materially from sulphur burners.

A notable step has been taken by Dr. Kedar Nath of Simla who has installed pyrites burners in his chemical works in Agra and the plant has yielded good sulphuric acid at competitive prices. To persuade existing sulphuric acid manufacturers in India to utilise pyrites, the price at which the pyrites can be offered to them should be such as to compare favourably with the price of raw sulphur, not only when allowing for the lower sulphur content but also for the capital expenditure necessary to substitute their existing sulphur burners with burners specially designed and made for the burning of pyrites. Owing to the paucity of sulphur, increasing amounts of pyrites both from Simla and the Sone Valley should be employed for manufacturing sulphuric acid.

Sulphuric Compounds from Coal and Oil.—Mr. N. L. Dutta has been associated with the Director, Scientific and Industrial Research, on investigations on the sulphur content of coals and oils. Investigations have been particularly carried out on "Wakting coal" and other coals of high sulphur content obtained from Dr. Fox of Geological Survey of India. The total sulphur of some of these coals have been found to be as high as 6·5 per cent. A substantial quantity of it is in the organic form so that it is possible to extract the sulphur compounds by solvent processes or steam distillation. The sulphur compounds as such or after chemical reaction produce materials which may be useful as anti-oxidants and as accelerators or retarders in vulcanizing processes. Preliminary work on these sulphur compounds has shown that extraction is pretty difficult but a number of important organic sulphur compounds have been extracted and their properties are being examined. This problem is of interest as these sulphur compounds are rather expensive and if they can be removed by a cheap process from the coal, the coal itself will become more useful and a good price could be fetched by developing the sulphur compounds.

Deposits of Sulphur and Sulphur-bearing Materials.—Perhaps the most important development in the sulphur position is the location of more than one sulphur mine in India. In literature the largest sulphur deposit in India is described as being located about 12 miles south-west of Sanni in the Kalat State, Baluchistan. Sulphur was at one time mined at the spot but these operations ceased some sixty years ago as a result of a fire. *The Records of the Geological Survey of India,* Vol. L, page 137 (1919) state that the deposit is estimated to amount to at least 36,000 tons of sulphur rock assaying approximately 28·8 per cent. of free

sulphur, which is equivalent to 10,000 tons of sulphur. The mine is 40 miles from Bellpat, the Railway Station. Sulphur also occurs in other parts of Baluchistan, *e.g.*, on the extinct volcano of the Koh-i-Sultan and other volcanic regions in the desert district of Chagai.

Recent work carried out by the Geological Survey under the auspices of the Board of Scientific and Industrial Research and the Sulphur Committee, has proved extremely fruitful and it is estimated that at one place in the surface deposits alone approximately thirty thousand tons of sulphur rock are available and mining operations will probably produce very much more. The deep boring operations in Baluchistan have been reported to be capable of yielding even larger quantities. Proposals are before the Government for working out the deposits in these two places and while the boring operations in the Sanni district have not yet been resorted to, there is no doubt that the success of the first deposit will lead to greater efforts on our part for obtaining more sulphur by boring. For obvious reasons it is not necessary nor desirable to give fuller details of the quantities of sulphur now required for India and the Eastern Group Nations in the British Empire, but it can be well imagined that the requirements will be large and for this reason, the report that the Simla mines of iron pyrites and the iron pyrites discovered in Sone Valley are not so small as they were at one time pictured, is of special interest. Iron pyrites have also been discovered in the Hyderabad State. The occurrence of sulphur and the large quantity of iron pyrites is a hopeful sign for the rapid development of sulphur sources in this country.

ANNALS OF BIOCHEMISTRY AND EXPERIMENTAL MEDICINE

THIS is a new addition to the specialist scientific journals in this country. The Journal "is meant to publish original papers. It also publishes reviews on scientific subjects and books and reports of scientific interest". The first number has sixteen contributions covering 116 pages.

In a foreword to the first number of the *Quarterly Review of Biology*, Raymond Pearl writes: "It is reported that there exist in the world to-day approximately 25,000 reputable scientific journals, devoted in whole or part to the publication of the results of research. In the face of such an overwhelming statistic it is entirely appropriate to raise the question: why start another? As the *Quarterly Review of Biology* stands, at the moment, in the position of the latest addition to the already large population of scientific journals, there is an obligation to make some statement as to its *raison d'etre*. This obligation may fairly be judged a moral one, because like all forms of population growth, that of scientific journalism shows definitely a tendency to approach a state of troublesome saturation." This statement was made fifteen years ago, in January 1926, and to-day it has greater significance.

In the light of the above, two questions may be asked: Was there a sound justification for a new journal? Could not have the existing journals satisfied the interests intended to be served by the new journal? These questions are important for a country whose budget for the advancement of science is miserably small.

The promoters of this new venture have, no doubt, considered these aspects and felt the need of a new journal in addition to those already existing. Let us hope that this feeling is shared by a large number of scientific workers in the country, whose sympathy and co-operation is essential in conducting and maintaining a high standard for the Journal.

We welcome the Journal and wish it a long and purposeful career.

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A SIGNIFICANT CASE OF MIRROR DRAWING

LEARNING a new type of eye-hand co-ordination has been the subject of elaborate experimental study, as well as of theoretical discussion. Dearborn,[1] Starch,[2] Hill,[3] and Snoddy[4] have drawn attention to the mirror drawing experiment as a striking example of learning by the method of trial and error. The impression has gained firm ground that in this experiment we have to look, apart from 'transfer', only for one factor, that is, the breaking up of an old co-ordination, and the establishment of a new one by trial and error. Whipple[5] commenting on this experiment, says, 'In the mirror-drawing test, the conditions preclude the use of imitation, and there is but relatively little opportunity to employ ideational control; whatever improvement appears is due primarily to a process of trial and error.' But, recently Ll. Wynn Jones[6] following the brilliant lead given by Gopalaswami[7] has shown the futility of the 'trial and error' attitude (inspired by mechanistic psychology) towards learning. "Until recently," says Prof. Jones, "it was customary to say that improvement in mirror drawing occurred through trial and error and that reasoning as such had little or no part. This attitude is characteristic of all 'mechanical' theories which involve the notion of random or 'chance' movements. Opposed to such views is the 'rational' theory of Professor Spearman. According to this theory 'rational' or 'intelligent' movement plays an important part in mirror drawing."

This is the first step in breaking off the shackles, imposed upon our thinking, by the mechanistic theories of learning. The next is to bring in *the conative factor* in learning. Stratton's famous experiment gave us the clue here. There the subject was very strongly motivated. He had perforce to achieve mentally the task of overcoming the effect of reversal. Could not the same effect be produced in the mirror drawing experiment? That was the problem which this variation of the usual experiment set out to solve.

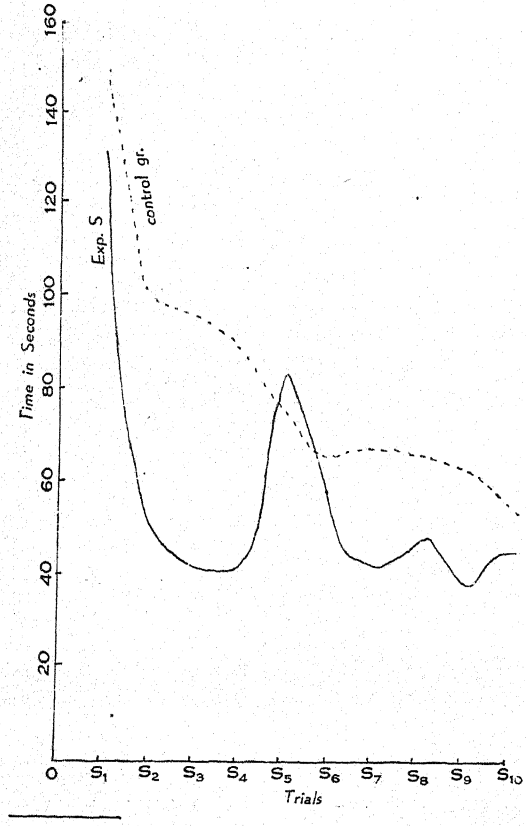
The usual outfit with the old type of the star-blank was used. The subject was an intelligent Honours Graduate of our School of Philosophy, who was familiar with details of the experiment. Ten trials were taken by the subject, in the mirror, with his skilled (right) hand. After S_1 a very strong incentive was given to make the subject highly motivated. He was told of the striking records in other laboratories, and when he was impressed, he was invited to beat those records

by devising some method of facilitating considerably his performance in the mirror. Suddenly, the possibility of a 'mental reversal' was hit upon, and the results are given below*:

Trial No.	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
Time in secs.	135	53	43	42·5	84	54	43·5	51	39·5	47

The average for a control group of three taking the test in the usual way without any suggestions from the experimenter is given below:

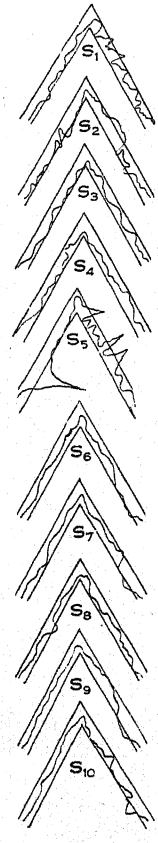
Trial No.	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
Time in secs.	148	100	97	90	75	67	69	68	65	57



* S, without mirror = 24 secs.
U, ,, ,, 31·5 ,,
U_1, with ,, 135 ,,

It is remarkable that even at the very first attempt (S_2) after the subject was strongly motivated, he was able to achieve a notable result in the shape of a reduction of 60·1 per cent. of the original time, while the control group produced only a reduction of 33·1 per cent. Moreover at no stage in the experiment did the control group achieve the result of the experimental subject in his first attempt after being strongly motivated.

Introspective results revealed that mental re-reversal was achieved, but the effort required was intense. There was a steady progress in the experiment as indicated by the graph up to the fifth trial, when suddenly the subject relaxed, and lost his 'mental picture'.



The result was a sudden shooting up of the time, and a consequent steep rise in the graph. E then kept on urging S to regain the picture.

There was success again, followed by another breakdown at the tenth attempt. The rise in time at the eighth attempt is due to external causes.

When the efficiency of the performance is considered, we get the same result. The third and the fourth arms of the star-blank have been chosen for reproduction in this note as the subject found them to be the most difficult. At S_5 many random and inefficient movements have been made, as well as at S_{10}.

So long as the subject was strongly motivated his performance was improving in time and efficiency. The sudden improvement at S_2 is noteworthy as due to the effect of a strong motive. It is clear then, that to speak of trial and error alone as the principle of explanation of learning in cases of this type is misleading. The conative factor must be taken into consideration. This experiment has opened up a new vista for the approach to the problem of learning which we expect to pursue in our further investigations.

P. S. NAIDU.

Annamalai University,
Annamalainagar,
November 15, 1940.

[1] Dearborn, *J. of Ed. Ps.*, 1910, **1**, 373–388.

[2] Starch, *Ps. B.*, 1910, 20–23.

[3] Hill, *J. of Ed. Ps.*, 1914, **5**, 375–386.

[4] Snoddy, *Ps. Monog.* 1920, **28**.

[5] Whipple, *Manual of Mental and Physical Tests, Complex Processes* (Warwick & York, Baltimore), 1921, p. 119.

[6] Jones, *An Introduction to the Theory and Practice of Psychology* (Macmillan), 1934, p. 69.

[7] Gopalaswami, *Br. J. of Ps.*, 1923–24, **14**, 274.

NATURE OF RECEPTORS IN THE HUMAN RETINA

THE normal photopic field of vision for a well-illuminated white object 10 mm. square at a distance of 45 cm. is a horizontally oval area extending upwards about 50°, outwards 90°, downwards 70°, and inwards 60°. It varies with intensity and quality of the stimulus, size of the test object and the state of adaptation of the eye. Field for colours are smaller by ordinary clinical methods those for blue and yellow pigmented objects are about 10° smaller than that for white and these for red and green 20° smaller, the green field being usually smaller than the red.

Ferree and Rand[1] have investigated the shape and size of fields for colour stimuli of equal energy. With stimuli of medium intensities of equal energy the limits of red and blue interlace. Those of green are narrower. Thus the green and red areas which are small in photopic field of vision extend to a greater limit.

Again when the eye is tested for fields of colour vision foveal region alone gives the unadultered photopic reactions unless the eye is very completely adapted to light so that all traces of scotopia are eliminated from the peripheral field. This point is often neglected by physiologists. As a result of which the foveal region and peripheral region do not give concordant results. The author by making the whole of the retina as far as possible photopic by exposure to sunlight for a long time (bearable by the author) and taking field of vision for colours (blue, red and green test objects 2 mm. diameter) has found out within the limits of experimental error blue zone, green zone and red zone are concentric in contradistinction to blue zone, red zone and green zone obtained with partially scotopic peripheral field.

Roaf[2] in his researches has found out that for central vision long wave-lengths raise the threshold for all regions of the spectrum and blue mechanism is stimulated by the whole spectrum,[3] whereas short wave-length of the spectrum stimulates only one set, *i.e.*, blue mechanism only.

For peripheral vision short wave-lengths raise the threshold for the whole spectrum. In his experiments the scotopic peripheral field was not made photopic and so he has obtained different results for peripheral vision. The author by eliminating all traces of scotopia from the peripheral field has secured the same

type of results as was obtained for foveal vision. This clearly points out that attention to photopic nature of peripheral field is important in all experiments conducted on colour vision in the periphery of the retina.

A. S. RAMASWAMY.

University Medical College,
Mysore,
April 5, 1941.

[1] Ferree and Rand, *Psychol. Rev.*, 1919, **26**, 150; 1920, **27**, 1; *Trans. Amer. Ophth. Soc.*, 1920, **18**, 244; *Amer. Jl. of Ophth.*, 1920, **3**, 772.

[2] Roaf, *Nature*, 1930, **126**, 825.

[3] Roaf, *Jour. Physiol.*, 69; *Proc.*, 1929, p. 1.

ROOT-ROT OF SUGARCANE

DURING August 1939 a portion of a sugarcane field planted to Co. 413 in the vicinity of the Agricultural Research Institute was infected by a root-rot disease. The crop was 3 months old and some of the plants were in a poor unthrifty condition with many of the leaves drying up in spite of the fact that there was sufficient water. When the diseased plants were dug up it was observed that the roots were few and diseased. The older roots were dead and dark brown in colour. The new roots showed red discolouration in several places along the length. In a few plants the base of the stem of shoots had rotted.

Sections of the diseased roots in various stages of infection showed the presence of hyaline non-septate hyphæ in the cortex. Oospores were also present in some sections. Bits of roots in the early stages of infection were washed in ·1 per cent. mercuric chloride solution for two minutes and then in sterilised water and placed in Petri-dishes containing quaker-oats agar. In three days white growths of a *Pythium* developed from most of the bits. From these the fungus was brought into pure culture.

On quaker-oats and french bean agars the fungus produces a luxuriant felt-like growth. Oospores are formed in plenty in a week. These are spherical, smooth and filling up most of the oogonial cavity. They measure 22·5μ (the range being 18·9–25·2μ) (Fig. 5). The oogonia measure 26·7μ in diameter (range, 21·0–29·4μ). One to four antheridia have been found attached to a single oogonium. Sporangia are spherical or oval (Fig. 1) and form terminally at the ends of long stalks. These are not common on solid media but when bits of culture are floated in distilled water they develop in plenty

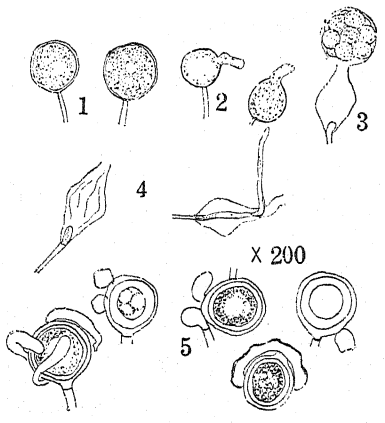


Fig. 1—Sporangia; Figs. 2-3—Germination of sporangia; Fig. 4—Proliferation; Fig. 5—Oospores.

in 24 hours. Small tubular outgrowths are produced by the sporangia and these form vesicles into which the protoplasm flows. Differentiation into zoospores takes place and the vesicle bursts liberating the zoospores 16–20 in number (Figs. 2–3). After the discharge of zoospores and in some cases just at that time, a hypha begins to grow through the sporangium starting from the point of attachment of the stalk to the sporangium. This hypha grows out and sometimes branches and continues the mycelial growth. This resembles one of the methods of proliferation observed by Butler[1] in *Pythium*. But sporangial formation at the tip of the proliferated hypha has not been observed. This isolate resembles *P. deBaryanum* excepting for bigger size of the oogonium and oospore. *P. deBaryanum* has been recorded as one of the species causing root-rot of sugarcane in Louisiana.[2]

Inoculations were made by placing cultures

of the fungus in the root region of sprouting setts of Co. 413 in pots. After 15 days the roots were found to be reddened and rotten and the fungus was reisolated from the diseased roots. Some plants were allowed to remain in the pots for two months. But they did not make good growth as compared with the controls. It was found that the root system in the inoculated plants was poor and consisted of a high percentage of dead and diseased roots. Thus the pathogenicity of this isolate on sugarcane roots was established.

Le Beau[3] has noticed in his experiments that applications of nitrates increased root-rot by *Pythium* in sugarcane. In Coimbatore the root-rot trouble commenced after the application of ammonium sulphate to the fields and it was more evident in the areas at a lower level. The fields were then flooded and drained alternately with water for a week with the idea of removing the excess of salts. The progress of the disease was arrested and there was no fresh infection after a week. This confirms Le Beau's observations on the relation between nitrate application and root-rot caused by *Pythium*.

T. S. RAMAKRISHNAN.
Agricultural Research Institute,
Coimbatore,
March 29, 1941.

[1] Butler, E. J., *Mem. Dept. Ag. Ind. Bot. Series*, 1907, **1**.

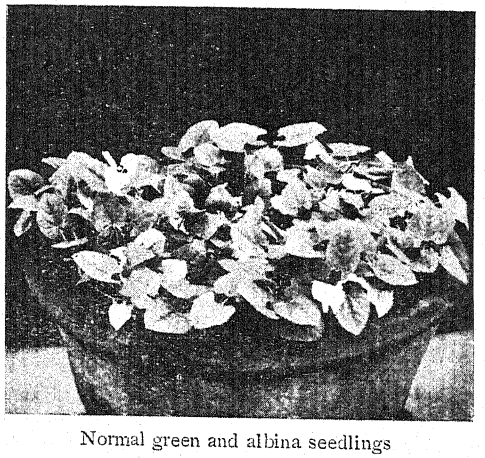
[2] Rands, R. D., and Dopp, E., *U. S. Dept. Ag. Tech. Bull.*, 1938, 666.

[3] Le Beau, F. J., *Rev. App. Myc.*, 1939, **18**, 618.

ALBINISM IN *LABLAB*

THE occurrence of a chlorina type of chlorophyll deficiency which has little or no lethal effect has been reported in the garden variety of lablab (*Dolichos lablab* L.).[1] The chlorina type is produced by a factor c_a while its allelomorph C_a is necessary for the normal green.

The occurrence and inheritance of an albina type in the field variety of lablab (*Dolichos lablab* Roxb.) is reported herein. Like the chlorina type, the albina type is met with in many species of plants.[2] It is more common in cereals than in pulses. The albina seedlings in lablab were observed in the F_2 generation of a cross for the pursuit of inheritance of testa colour pattern. The parents and the F_1 were normal green while the F_2 gave 156 normal green and 44 albina (Fig.). The albina



Normal green and albina seedlings

plants died when about 12 days old. From the normal green plants 20 selections were carried forward to the next generation. Eight of these bred true for normal green while twelve segregated, giving a total of 663 normal green and 210 albina plants. This experience is the first record of a monogenic segregation for albinism in the pulse *Dolichos lablab* Roxb.

G. N. RANGASWAMI AYYANGAR.
K. KUNHI KRISHNAN NAMBIAR.
Millets Breeding Station,
Coimbatore,
April 19, 1941.

[1] *Proc. Ind. Acad. Sci.* (B), 1935, **1**, 857.

[2] *Bibliogr. Genet.*, 1933, **10**, 357.

TRICOTYLEDONY IN *LABLAB*

THE occurrence of tricotyledonous seedlings is a fairly common phenomenon in the dicots. According to Buchholz[1] who examined the embryos of pine, spruce, larch, juniper, etc.,

the polycotyledonous condition is primitive and the dicotyledonous one derived. On the basis of this theory, Gager[2] concludes that the rather common abnormal appearance of supernumerary cotyledons in the dicots is a reversion to a more primitive condition. De Vries[3] calculated the heredity percentage of tricotyls in several species of plants and observed that this percentage is higher in the cultivated plants.

At the Millets Breeding Station, Coimbatore, a tricotyledonous seedling was observed in the garden variety of lablab (*Dolichos lablab*, L.). The seedling had three distinct cotyledons, of which one was more or less normal in size, the other two being smaller. The first foliar leaves in this seedling were as usual simple, but were three in number instead of the normal two. This tricotyledonous seedling was grown to the adult stage and out of 449 of its seeds examined (from 100 pods) 10 were found to be tricotyledonous as well as having three simple first foliar leaves.

G. N. Rangaswami Ayyangar.
K. Kunhi Krishnan Nambiar.
Millets Breeding Station,
Coimbatore,
April 19, 1941.

[1] *Amer. Jour. Bot.*, 1919, **6**, 106.

[2] Gager, C. S., *Heredity and Evolution in Plants*, 1920.

[3] Vries, Hugo de, *Species and Varieties: Their Origin by Mutation*, 1906.

A NEW TYPE OF MECHANICAL CONSTRUCTION IN THE STEM OF *PANICUM PUNCTATUM* BURM.

Monocotyledons are particularly characterised by an extraordinary degree of variation in the types of mechanical construction of their inflexible organs. Schwendener[2] noted 28 types of such construction in this class alone, and arranged them into a number of mechanical systems. But the type under discussion has not been reported, so far as the writer can find out, by Van Tieghem, Schwendener or Haberlandt.[1] As a detailed report on the anatomy of this plant will form the subject-matter of another paper, only the mechanical construction of the adult stem is described here.

The epidermis and one or two hypodermal layers have their walls thickened and lignified to form the hard rind characteristic of the Grass family. The subhypodermal ground tissue is characterised by the presence of a ring of air cavities which run in longitudinal rows through the internode. The vascular bundles are arranged in radial rows at regular intervals occupying the regions between successive air cavities, the largest bundles being always towards the centre of the stem. The stereome runs in the form of an inverted arch encircling more than half of each air cavity on the inner and lateral sides and joining firmly to the top of the vertical piliars built up of the composite girders formed by the bundles in each radial row. The centre of the stem is occupied by a big cavity formed by the disorganisation of the pith cells (Fig. 1).

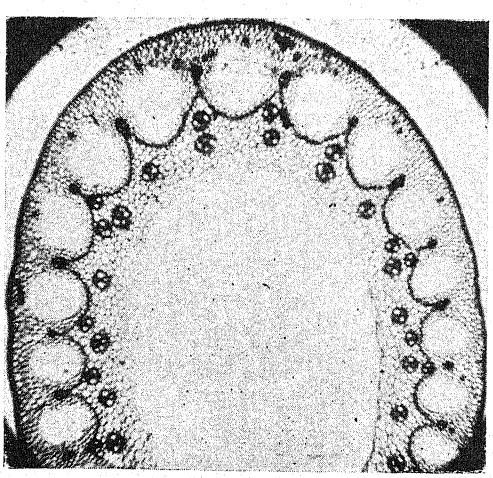


Fig. 1

T. S. of adult stem

The plant grows in water and mud, and is subjected to lateral compression and bending. In this case the mechanical construction, it appears, has been followed on the principle of the construction of a suspension bridge instead of that of an I-girder. A suspension bridge

"consists of two or more chains constructed of links connected by pins or of twisted wire strands, or of wires laid parallel. The chains pass over lofty piers on which they usually rest on saddles carried by rollers and are laid down on either side to anchorages in rock chambers". Thus in a suspension bridge *three* things are necessary, *viz., lofty towers* over which the *wire ropes* of very great tenacity passes, and the *massive anchorage.* The lofty towers in this case are the vertical pillars constructed on the girder principle, the wire ropes are the continuous inverted arches of stereome, and the anchorage instead of being local and massive is more efficient and economical in the fact that the stereome is continuous round the stem in the form of a wavy ring passing at definite intervals over vertical towers. When compressed due to a temporary load (stress) any deflection is resisted by the stereome tissue as a whole.

What is considered a defect in a suspension bridge, *i.e.,* its flexibility, is in fact a necessity in the stem of these plants. As regards the material of the wire ropes iron and steel of strongest form is used, and the tensile strength of sclerenchyma cells, of which the stereome is constructed, is equal to that of wrought iron (15–20 kilograms per sq. mm.), and in some cases "vies even with steel in this respect". Its strength increases with diminishing water contents, while its elasticity is correspondingly diminished making the older parts of the stem more rigid than the younger ones.

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Department of Botany,
Presidency College, Calcutta,
April 1941.

[1] G. Haberlandt, *Physiological Plant Anatomy*, Eng. Ed., 1914.

[2] S. Schwendener, *Das Mechanische Princip im Anatomischen bau der Monocotylen*, 1874.

THE DEVELOPMENT OF ENDOSPERM IN *LEUCAS ASPERA* SPRENG.

SCHNARF[1] (1931) has summarised the literature on the embryology of the Labiatæ. The more recent investigations on endosperm development in the family include those of Ruttle[2] (1931) on *Mentha*, Carlson and Stuart[3] (1936) on species of *Salvia*, and Junell[4] (1937), who has investigated a large number of representatives of the family. But the investigations are mainly confined to European and American species and the information regarding the species indigenous to India has been very meagre. The author[5] (1940) has published an account of the development of the embryo-sac and endosperm in three species of *Ocimum*. The present study is a short account of the development of endosperm in *Leucas aspera*. The detailed paper on the embryology of this species will be published elsewhere.

Soon after fertilisation, the secondary nucleus migrates to the narrow chalazal region of the

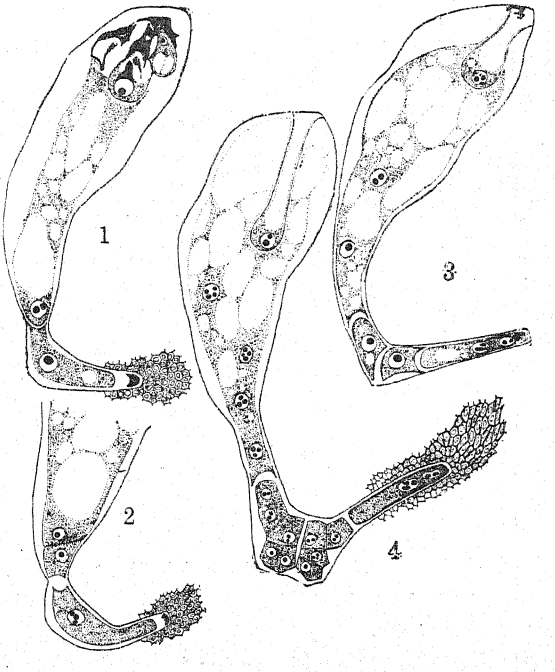

Fig. 1—First division of the primray endosperm nucleus. × 800. Fig. 2—Chalazal portion of the embryo-sac showing the chalazal haustorial cell, middle cell, and micropylar chamber containing the nucleus. × 800. Fig. 3—Embryo-sac showing the chalazal haustorium, endosperm cells, two-nucleate micropylar haustorium and the fertilized egg × 800. Fig. 4—Embryo-sac showing the chalazal haustorium entering the vascular bundle, the endosperm tissue, 4-nucleate micropylar haustorium and the elongated fertilised egg. × 800.

embryo-sac, where it divides followed by a transverse wall (Fig. 1). Of the resulting two cells, the nucleus of the chalazal cell divides once without any wall formation. The resulting two nuclei organise a chalazal haustorium which penetrates the vascular trace. The upper of the two cells divides transversely, separating a middle cell and a large micropylar chamber (Fig. 2). The middle cell, by transverse and vertical divisions, gives rise to the endosperm tissue (Figs. 3 and 4). The nucleus in the micropylar chamber of the embryo-sac divides in a free nuclear manner and gives rise to a number of nuclei which organise a micropylar haustorium (Figs. 4 and 5). The embryo-sac is thus divided into 3 portions, *viz.*, a chalazal haustorium, cellular endosperm region and a large micropylar haustorium. The fertilised egg elongates into a long suspensor without any cell division and becomes encased in the developing endosperm tissue, where further development takes place.

The activity of the chalazal haustorium is of short duration, and it can be observed only at the early stages of the growth of the endosperm tissue. The contents of this haustorium disappear by the time the micropylar haustorium is fully organised so that a mere empty canal is left to denote its original position (Fig. 5). The micropylar haustorium, on the other hand, develops aggressively and extensively absorbing a large portion of the integumental tissue. At the height of its activity it shows twelve large nuclei embedded in dense cytoplasm (Fig. 5). The connection between the micropylar haustorium and the endosperm tissue is by a narrow isthmus formation through which the nutrition absorbed by the micropylar haustorium is transported to the developing endosperm tissue. The nuclei of the micropylar haustorium contain two to three nucleoli. Later stages of the haustorium are characterised by the disintegrating cytoplasm containing amœboid nuclei (Fig. 6).

The development of the endosperm tissue, in the early stages, extends towards the chalazal part of the ovule where a large amount of the chalazal tissue is absorbed. At this period the micropylar haustorium is very active digesting the micropylar tissues. The further development of the endosperm extends towards the micropylar part of the ovule

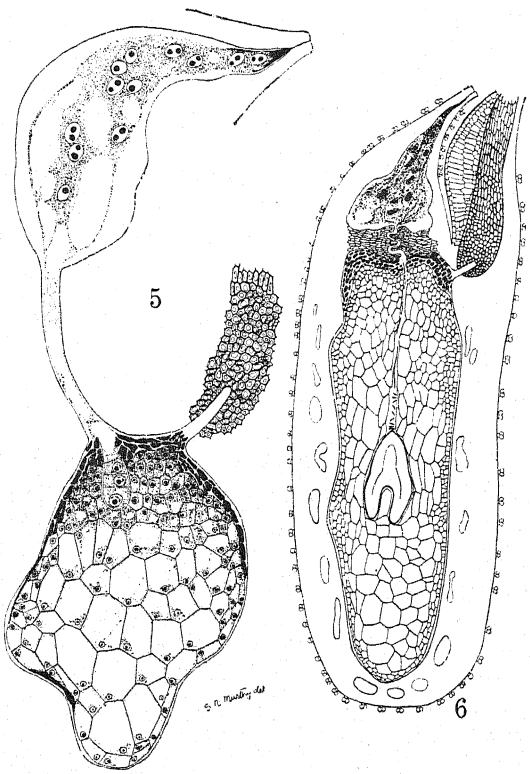

Fig. 5—12-Nucleate micropylar haustorium, the proembryo embedded in the endosperm tissue and an empty canal representing the chalazal haustorium. × 560.
Fig. 6—Section of ovule showing the embryo in the centre of the endosperm tissue, the disintegrating micropylar haustorium with amœboid nuclei, and the glandular hairs. × 240.

gradually obliterating the micropylar haustorium. The isthmus which connects the micropylar haustorium with the endosperm tissue becomes twisted and crushed (Fig. 6). The micropylar haustorium itself soon becomes empty giving place to the advancing endosperm tissue which, later, occupies most of the ovule. The peripheral cells of the endosperm tissue transform themselves into highly chromatic conducting cells, and the cells towards the centre are larger and less chromatic.

The embryo develops in the middle of the endosperm tissue (Fig. 6) and finally displaces it.

The formation of two-celled glandular hairs on the ovule after fertilisation has been noticed in this species. These glandular hairs persist for a long time during endosperm development.

In conclusion, the author wishes to record his sincere thanks to Dr. M. A. Sampathkumaran, Professor of Botany, for his kind criticisms.

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Department of Botany,
Central College, Bangalore,
April 5, 1941.

[1] Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.

[2] Ruttle, M., "Cytological and Embryological Studie on the Genus *Mentha*," *Gartenbauwiss*, 1931, **4**, 428.

[3] Carlson, E. M., and Stuart, B. C., *New Phytologist*, 1936, **35**, No. 1, 68.

[4] Junell, S., *Sartryck ur Svensk Botanisk Tidskrift*, 1937, Bd. 31, Hft. I.

[5] Narasimha Murthy, S., "Studies in the Labiatæ, I" *Journal of the Mysore University*, 1940, **1**, Part 10, 97.

ON TWO KINDS OF FISH EGGS HATCHED OUT IN THE LABORATORY OF WEST HILL BIOLOGICAL STATION, CALICUT*

The occurrence of two types of fish eggs, namely, those of *Anodontostoma chacunda** and of *Caranx crumenopthalmus* in the plankton obtained from a depth of 4 fathoms at a distance of 2 miles from the shore, opposite the Marine Biological Station, in January 1940, aroused fresh interest in the study of fish eggs which is one of the routine items of work in the Biological Station. Both fishes are economically important. The horse mackerel is more abundant than the other in the West Coast and on an average about 55,000 maunds of fish valued at Rs. 52,000 are landed every year. In the year 1938–39 this fishery yielded a maximum of 229,257 maunds valued at Rs. 1,70,416.

* Published with the permission of the Director of Industries and Commerce, Madras.

I. Anodontostoma chacunda

Five batches of eggs of this fish came under observation in January 1940 on the 15th, 16th, 17th, 24th and 29th respectively. They were isolated from the inshore plankton off West Hill. As this fish was practically absent in the catches made by the fishermen in January, one is led to conclude that they were spawning off shore beyond the reach of the fishermen. By special efforts, two specimens of this fish were obtained through the assistance of the hook and line fishermen† from the off shore 10 miles away. Both happened to be females with ripe ovaries. The ova were transparent. Needless to say, artificial fertilization could not be tried in the circumstances.

8 A.M. The eggs were identified as those of *Anodontostoma chacunda* with the help of Delsman's description.[2] The eggs found in the morning plankton were fairly advanced in development, suggesting that they might have been laid the previous night, as is well known in the case of most of the fishes in tropical waters. The eggs are of a slightly yellow colour but the oil-globules are colourless. The embryo is formed showing the head-fold and the tail-fold. The diameter of the entire egg is about 0·82 mm. The number of oil globules is 6.

9 A.M. After the lapse of one hour, the egg swells a little, evidently through the absorption of water, for its diameter has now increased to 1·05 mm. The number of oil-globules is 12. It could not be ascertained if this increase in number was due to a division of the original oil-globules or to the addition of oil-globules which rose *de novo*. The head of the embryo is differentiated; optic vesicles are formed and the tail becomes a little curved at the other end, thus showing the progress in the growth made by the embryo. The chromatophores make their appearance in the middle portion of the embryo.

11 A.M. At the end of 3 hours the curved embryo has embraced the yolk completely, the diameter of the egg being 1·14 mm. and there are 20 oil-globules. These are no longer distributed over the yolk mass but are crowded

together at the region corresponding to the middle of the future larva and the posterior portion of its yolk-sac.

About 1 P.M. the larvæ generally hatch out. Their average length is 2·66 mm. The eyes are well developed. The auditory vesicles are formed. The contraction of the heart is evident. The oil-globules are collected at the posterior region of the yolk-sac. The anus is at a distance 1·88 mm. from the tip of the head. There are 35 myotomes in front of the anus and 12 behind it. The chromatophores make their appearance along the dorsal region of myotomes and are also found in the head region above the auditory vesicle.

In twenty-six hours, the larva has grown to a length of about 4·28 mm.

The larvæ that hatched out on 29–1–1940 lived for 36 hours. Their length was 4·35 mm. The heart was slightly bent in the shape of 'S' and its contractions can be seen clearly. The eyes have become deeply pigmented. The yolk has been completely absorbed. The pectoral fins make their first appearance as lobes. There are now 25 myotomes in front of and 22 behind the anus. According to Delsman there are 41 myotomes in the larva corresponding to the 41 vertebræ in the adult. But the larvæ in question had 47 myotomes. Further investigation appears to be necessary to reconcile this difference.

The phenomenon of the forward movement of the anus and the consequent reduction in the length of the trunk and increase in the length of the tail well known in the development of certain fishes is also seen here.

There are not many differences between the eggs described by Delsman and the eggs described by us. The fish according to the observation of Delsman spawned in the sea off Batavia in March where the water had a salinity of $29^0/_{00}$. He had also collected the fish eggs near Labuan, in September, where the salinity was $33^0/_{00}$. The salinity of the water off West Hill where we got these fish eggs was about $33^0/_{00}$. The fact that these fish eggs were also found in the plankton off West Hill from November 1939 till the end of February 1940 suggests that the spawning season of this fish extended from November to February during the period under our observation.

II. Caranx crumenopthalmus

In Indian waters no less than 26 species of caranx occur according to Day and the task therefore of referring the carangoid eggs found in plankton to the particular species will be a laborious one. According to Delsman[3] the eggs of the genus caranx are characterised by (*a*) the frothy nature of the yolk mass in the egg and by (*b*) the presence of a single large oil-globule in the anterior part of the yolk-sac in the newly hatched larva.

In the plankton collected in the sea off West Hill, eggs of the description given by Delsman are of common occurrence. In January of 1940, a carangoid egg happened to be abundant which event facilitated hatching. Three batches of eggs were hatched on 15–1–1940, 24–1–1940 and 29–1–1940 respectively. The colour of the egg was light yellow; the diameter of the egg was about 0·78 mm.; and the single large oil-globule measured about 0·24 mm. which is nearly a third of the diameter of the egg. The yolk mass was vacuolated. It should be stated that these eggs when isolated at 9 o'clock in the mornings, were in a state of advanced development. The embryo has been differentiated, the head and tail being prominent. This naturally leads one to believe that they must have been laid during the previous night. The oil-globule showed brownish red pigment-spots. This character distinguishes the eggs of carangoids from those of clupeoids which is the only other group of fishes that possesses eggs having vacuolated yolk.

Most of the eggs isolated in the laboratory hatched out at about 1–30 P.M. The length of the newly hatched larva is 1·35 mm. The oil-globule is in the anterior portion of the yolk-sac. The length of the tail is 0·75 mm. and the diameter of the oil-globule 0·15 mm. There are 7 myotomes in front of and 17 behind the anus. As regards the number of

myotomes, Delsman (3, p. 209) observed as follows:—

"For the number of trunk myotomes I found as a rule 12 sometimes 11 or 13, for those of the tail some 14, although in quite young larvæ, newly hatched, this number might amount to 16 or 17, besides the unsegmented part of the mesoderm corresponding to the urostyle. From this it is evident that the number of trunk myotomes as well as that of the tail myotomes decreases slightly during development. As stated above, the number of vertebræ in both species is 10 *plus* 14 (the urostyle included)."

Our observation does not support Delsman in this respect. The total number of myotomes was 24 in the larva corresponding to the 24 vertebræ of the adult carangoid.

These larvæ as soon as they hatch out were found swimming at the bottom of the vessel and not coming up to the surface. This perhaps indicates that in the sea the larvæ as soon as they hatch out descend down seeking the lower strata of the sea. The length of the larva, 20 hours after hatching is 1·95 mm. and the diameter of the oil-globule 0·1 mm.; the latter shows a reduction in size due to the oil being used up. There are 7 myotomes in front of and 17 behind the anus. A larger portion of the yolk-sac is absorbed. There are three distinct patches of chromatophores along the ventral side of the myotomes posterior to the anus. The head is slightly opaque. Two dark patches of melanophores are found in the anterior portion of the head.

In the next stage examined, *i.e.*, 44 hours after hatching, the length of the larva is 2·4 mm. There are 10 myotomes in front of and 14 behind the anus. The anus has shifted backward a process just the opposite to what was observed in the case of the larva of *Anodontostoma chacunda*. The eyes have almost turned black with a silvery eyelid. Chromatophores make their appearance along the dorsal portion of the myotomes in three patches. When the larva is 64 hours old, the yolk is completely absorbed. The eyes have become very dark and the auditory vesicles are well developed.

Delsman[3] has found the eggs of *Caranx crumenopthalmus* in plankton collected in May and June in the Java Sea. This perhaps indicates that this horse-mackerel has a different spawning season in the Arabian Sea. It is also interesting to note that generally this horse-mackerel locally called "Chamban" in Malabar is very rarely caught by the fishermen during the months of January and February. This fish is landed in plenty from July to November.

In the case of eggs of both the fishes described above, it is highly interesting to note that they are fairly common in the plankton during the months when the parent fishes are rarely caught. The inference, therefore, that during the spawning season these fishes seek breeding grounds far away from the shore beyond the fishing zone of the fishermen does not seem to be unreasonable.

D. W. Devanesan.
K. Chidambaram.

West-Hill Biological Station,
Calicut,
May 17, 1941.

* We have adopted this name from C. Tate Regan (5). Day's name for this fish is *Chatoessus chacunda*.

† These fishermen go beyond the zone usually fished by net fishermen.

[1] Day, F., *Fauna of British India · Fishes*, **1 & 2.**

[2] Delsman, H. C., *Fish-eggs and Larvæ from the Java Sea*, 1926, No. 8, p. 389.

[3] —, *Ibid.*, No. 5, p. 199.

[4] —, *Ibid.*, Nos. 6, 7.

[5] Regan, C. T., *Ann. Mag. Nat. Hist., Eighth Series*, **19**, No. 112, p. 316.

MICRO-ESTIMATION OF NITROGEN BY OXIDATIVE DIGESTION

Oxidative digestion[1] has been successfully applied to the rapid micro-estimation of total nitrogen in biological materials. The procedure is simple and rapid and may be outlined as follows:—

An aqueous solution or suspension (1 ml.) of the material is pipetted into a micro-Kjeldahl flask and treated with 2 ml. of

concentrated sulphuric acid (nitrogen-free, if available) and a small pinch (*Ca* 50 mg.) of mercuric oxide (this is to prevent possible interference from halides). The suspension is raised to boil, and, while it is boiling, an aqueous solution of chromic acid (100 per cent.; 0·2 to 0·3 ml.) is added drop by drop until a red brown colour is definitely established. (If the material is rich in organic matter, a larger quantity of chromic acid may be needed.) The boiling is continued with a moderately low flame for 5 minutes after which the digest is cooled and diluted with 5 to 10 ml. of ammonia-free water. Sodium sulphite (or bisulphite) (A.R.) is then added until the red brown colour is completely discharged and a pale green or bluish grey colour is developed. (Smell of sulphur dioxide will also be quite pronounced at this stage.) A small pinch (*Ca* 10–20 mg.) of pure zinc powder or dust is then added and the suspension boiled over a low flame for about 10 minutes. It is then cooled and distilled with excess of alkali from a micro-distillation apparatus in the usual way.

If the nitrogen content of the material is small, a larger volume of the aqueous solution or suspension may be taken, and, after addition of a drop of concentrated acid, the volume is reduced, by boiling, to under 1 ml. before introducing sulphuric acid.

The above operations can all be conducted at the work-bench in the laboratory. If the details are carefully followed and the height of the flames suitably adjusted, no acid fumes (or other offensive smell) are given out. A micro-Kjeldahl flask is convenient for the digestion, but in its absence, even an ordinary boiling tube (made of Pyrex or other resistant glass) may be used.

An important condition for success is that, at no time, after the commencement of heating and till the completion of digestion, should the temperature be allowed to drop below 130° C. Otherwise, there will be loss of nitrogen in elementary form (through decomposition of ammonium dichromate) with the result that fictitiously low estimates will be obtained. A safe procedure will be to keep the mixture constantly on the boil and to see that there is no slackening until the five-minute period is over. For the same reason, a cooled digest should not be re-heated until after reduction with the sulphite.

The titrations are carried out from the micro-burette. The Conway burette is more accurate, but requires careful manipulation. The titration method is not, however, quite reliable when the total nitrogen content is less than 10 μg. In such cases, independent checks by the colorimetric method against standard ammonium chloride (1 μg. of nitrogen per ml.) should be carried out.

The above procedure has been repeatedly compared with the ordinary method of Kjeldahl digestion using selenium as catalyst, and allowing for slight difference in blanks, identical results have been obtained in both the cases.

The method of oxidative digestion has been successfully applied in enzyme fractionation studies and has been of much value in rapidly assessing the degree of purity at each stage.

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Bangalore,
March 1941.

[1] Subrahmanyan, Narayanayya and Bhagvat, *Proc. Ind. Acad. Sci.*, 1934, **1B**, 155; Narayanayya and Subrahmanyan, *Ibid.*, 1935, **2B**, 213; Harihara Iyer and Rajagopalan, *J.S.C.I.* 1935, **54**, 341T; Acharya, *Nature*, 1935, **136**, 644; Bhaskaran, Harihara Iyer, Rajagopalan and Subrahmanyan, *I. Ind. Inst. Sci.*, 1936, **19A**, 45.

REVIEWS

Cotton. By H. B. Brown. Second edition. (McGraw-Hill Publishing Co., Ltd.), 1938. Pp. 592. Price 30*sh.*

The appearance of a good book on cotton is a matter of special interest to Indian research workers on this important commodity. As proved by scientific and incontrovertible evidence, India was the first country to grow cotton on a fairly large scale and to use it for the manufacture of materials. During the middle ages the fame of its fabrics, its muslins and nainsooks, spread far and wide, indicating the presence of suitable raw material and a high degree of technical skill in the arts of spinning, weaving, dyeing, printing, etc. To-day, India produces the second largest crop in the world; and though the average quality of its cottons is not so high as that of the Egyptian or the American cottons, strenuous efforts are being made to grow better and still better types, and already a notable measure of success has been achieved in this direction. For all these reasons, we scanned with interest the pages of the second edition of Dr. H. B. Brown's book entitled *Cotton* and found, with a sense of pleasurable relief, that our labours were not wasted in any way.

Brown's book first made its appearance in 1926 and the present edition has been necessitated by the manifold advances made in the recent years in the domains of cotton breeding, study and control of cotton pests and diseases, and marketing and manufacture of cotton. The scope of the book is indicated by its sub-titles, which are as follows: History, Species, Varieties, Morphology, Breeding, Culture, Diseases, Marketing, and Uses. These sub-titles would give the reader a fair idea of the wide ground attempted to be covered by the book, which is profusely illustrated by graphs and diagrams and supplemented by tables containing useful data. Each chapter is followed by bibliographic references, for those who wish to pursue the subject further, to books and journals in which the subject-matter has been discussed at greater length.

Though the title of the book is perfectly general and a few references are to be found, scattered here and there, to non-American, especially the Egyptian varieties, the book deals mostly with the American cottons. Treatment on these lines may ensure continuity and impart an air of intensity; but, on the other hand, it is bound to narrow down the usefulness of the book, especially to non-American readers, by omitting to take into account the work that is being attempted in other countries. Thus, to take a few examples relating to Indian cottons only, no mention is made of the work done in Bombay Province on wilt resistance, in Madras on pampheres, in the Punjab on the development of Punjab–American types or at the Technological Laboratory on the relationships between the fibre-properties and the spinning quality of cottons. This paucity of treatment of non-American cottons cannot be entirely due to want of space, because certain portions of the book, *e.g.*, the history of Ely Whitney's litigations, are in our opinion unnecessarily discursive, and could well have been abridged without detracting from its value. Furthermore, the book contains, now and then, statements which seem to be the legacy of the past and remind one of the views sometimes expressed by old-fashioned practical carders and spinners. Thus, it is stated that "if their (fibres') diameter and twist or convolutions are uniform, they will fit together closely, thus making a strong thread". Actually, as anyone who has spent some time with a microscope on cotton fibres knows, uniformity of diameter or convolutions may be dreamt of as praiseworthy ideals, but are never achieved in practice.

In spite of these few drawbacks, to which we thought it our duty to draw attention, the book is a mine of useful information on most aspects of cotton, especially the American cottons, and the author has done well to bring out an up-to-date edition. There are certain chapters, such as those on economics of cotton production and cotton marketing, which should be carefully and widely read in India, where we have to learn a great deal from the experience gained in America. We can, therefore, confidently recommend this book, and hope that the new edition, like its predecessor, will find a place on the shelves of all those interested in cotton.

NAZIR AHMAD.

Corrosion of Iron and Steel. By J. C. Hudson. (Chapman & Hall, Ltd., London), 1940. Pp. 319. Price 18*sh.*

The annual loss to the world as a result of the wastage caused by the corrosion of

iron and steel is computed at more than several million pounds sterling. Although the evils of corrosion are commonly understood and have been known for ages, the problem of finding its causes, and steps to prevent deterioration of the metal due to corrosion is so complicated that until recently no scientific attempt was made for tackling it. About two decades ago, a Joint Committee was set up on behalf of the British Iron and Steel Institute and the Iron and Steel Federation to investigate this question. This Committee, consisting of eminent members of various Research Associations and practical steel makers and users, has, up till now, produced five valuable reports, which contain numerous experimental data collected from various service stations in different parts of the world, working under the control of the Committee.

The mass of information contained in these reports is so voluminous and of such detailed nature that it was felt that practical steel users, interested in corrosion, would have no time to go through these. The Committee, therefore, authorised one of its members, Mr. J. C. Hudson to publish a brief book on "the corrosion of iron and steel" giving a brief account of the reasons for corrosion, qualities of steel and iron that get most easily corroded, the agents of corrosion and finally the remedies to be adopted for minimising the effects of corrosion.

The earlier chapters of the book deal with the oxidation of iron and steel at elevated temperatures, the significance of rolling mill scale on the rusting process, and other corroding agents of iron and steel, *viz.*, atmosphere, sea-water, etc. Detailed account of the rusting of iron and steel in atmosphere and the practical suggestions given for prevention of this evil are full of interest. Use of low alloy steels containing small percentages of copper and chromium for steel structures, and various kinds of protective coatings for iron and steel are practical suggestions which should prove of considerable interest to designers of steel structures. As a result of elaborate investigations conducted by one of the Sub-Committees, detailed instructions have been suggested to the practical user of steel regarding the nature of paints to be used, the preparation before painting of the various steels to be protected, nature of inhibitive priming coats and finishing paints, as also compositions of suitable priming and finishing paints.

It may be of interest to users of steel in this country that the premier steel producing company in India, *viz.*, The Tata Iron and Steel Company, have, during the last few years, put on the market a special non-corroding steel, called by name, 'Tiscor' used for various steel structures.

The remedies for prevention of corrosion against chemical attacks—a problem of great importance to chemical industries—are briefly referred to. Extensive types of steels which are generally recommended for this purpose, *viz.*, stainless steels, containing large percentages of chromium or chromium and nickel have been dealt with. A comparison is made of these special types of steel with the mild steel as also of ferrous and non-ferrous metals. The variations in the rate of rusting are noted.

The last few paragraphs give a clear description of the importance of fundamental research and laboratory work. The actual work conducted at the various research institutions and universities and the uses to which these results have been put to are all described in detail. An account of the field tests conducted in various countries—United States of America, Belgium, France, Germany, etc.—is also referred to. Further, a survey is given of the present state of knowledge of soil corrosion, as also of the atmospheric corrosion of wires and the corrosion of steel sleepers.

The concluding part of the book touches on what remains to be done for preventing rusting. The author recommends several improvements in painting procedure and suggests subjects for further research on atmospheric corrosion, soil corrosion, marine corrosion, etc.

On the whole, any reader who glances through the book will be highly impressed with its extensive scope and the very efficient manner in which the mass of details worked out by the main Committee have been condensed into easily understandable matter. One has no hesitation in stating that the book should prove of great service to all who are to deal with the manufacture, fabrication or sale of ferrous products.

D. V. KRISHNA RAO.

Sedimentary Petrography. By H. B. Milner. (Thomas Murby & Co., London), 1940. Third edition. Pp. xviii + 666, 100 figures, 52 plates. Price 45*sh.*

This well-known book has now reached a third edition. The second edition, published in 1929, had 514 pages, whereas the latest edition has increased to 666 pages of

a larger size (5" × 8½"). New detail has been added to all the old chapters, and chapters now appearing for the first time include one on physical examination by means of X-Ray Crystal and Spectrum analysis, Fluorescence, etc., and two on the study of soils and applied sedimentary petrology.

It is impossible to review in detail the wealth of material present in this book, familiar in any case to those who have used the earlier editions. Its author has not only added to knowledge of the broader principles underlying the distribution and provenance of detritals, but has worked extensively on the commercial applications of sedimentary petrology. It is this combination of research with purely scientific motives and research on economic problems which is so valuable, leading to an appreciation of what methods are ideally desirable, and what, as in the case of daily routine work in petroleum geology, are actually attainable. Particularly interesting chapters on the more academic aspects of the subject are those discussing principles of correlation and palæogeographical problems, while the practical applications are seen in accounts of oil sand differentiation and correlation, soil study, and applied sedimentary petrology. The asphalt industry building and cement technology, refractories, ceramics and even forensic geology are all briefly discussed.

Many of the methods outlined in this book take much time, and cannot be carried out by field geologists who, in the course of a single season, may have to examine igneous, sedimentary and metamorphic rocks, as well as ore deposits and problems of water supply. The final comprehensive study of the separate aspects of the field geologists' work tends increasingly to be handed over to a body of specialists, more or less permanently stationed in laboratories. There is perhaps a danger in this division of labour and specialisation, and in the multiplicity of elaborate devices required to establish the nature of a single grain, essential though such technique is. But specialisation has invaded geology in the same way as the other sciences, and for any adequate understanding of regional geology collaboration between field geologists and laboratory specialists becomes increasingly necessary.

In India, where distances are great and research grants in universities are small, research in sedimentary petrography would seem to offer increasing scope for students who cannot afford to carry out extensive mapping in interesting but out of way places. It may be hoped that co-operation between the universities and the Geological Survey of India may further develop in the future. In the field of sedimentary petrography there should result valuable generalisations about the manner of formation of the Purana and Gondwana sediments. Oil companies have already done much work on the tertiary formations, but the results lie for the most part buried in competitive secrecy.

As is customary in Murby's geological publications, the illustrations are excellent. The photomicrographs of individual mineral grains are one of the most striking and helpful features of the book. It only remains to state that the latest edition of this book is essential for any research work carried out on sediments.

J. B. AUDEN.

Classical and Modern Physics. By Harvey E. White. (Chapman & Hall, Ltd., London), 1940. Pp. 712. Price 21*sh.* net.

The title of this book may lead one to imagine that it is one of the now fairly numerous publications concerned with what is styled as a 'philosophical' discussion of the classical and quantum mechanical aspects of physics. Really, however, it is an elementary text and as the author puts it "a descriptive introduction" to the fundamentals of physics. Prof. H. E. White, who is the author of an excellent treatise on 'atomic spectra', which is much valued by all serious students of spectroscopy, has found time to produce an elementary textbook in which 'that phase of natural phenomena now classified as modern physics and atomic structure has been treated in greater detail' than is done in ordinary physics text-books. The treatment is mainly descriptive, all complicated mathematical processes including the calculus being scrupulously avoided. In addition to the usual subject-matter found in elementary texts, there are chapters devoted to X-rays, radioactivity, photo-electricity, cosmic rays, artificial atomic disintegration including the latest discovery of nuclear fission. The concluding sections of the book deal with astrophysics—the sun, the stars and the theory of relativity.

Each chapter deals with an historical account of the discovery followed by an experimental demonstration of the phenomenon, practical applications and a short account of the accepted theory. A set of questions and simple numerical problems

based on the subject-matter of the text are included at the end of every chapter. The book is profusely illustrated with excellently drawn sketches and good photographs. As a thoroughly sound and up-to-date elementary exposition of the fundamentals of physics, both in its so-called classical and modern aspects, the book under review will have few rivals. Teachers of physics in intermediate and technical colleges will find it an excellent reference book. The author has demonstrated that it is possible to present to the beginner the fundamentals of modern physics in an entertaining and intelligible manner, without using much mathematics. Scientists, whose specialised activity is in branches of science other than physics and who wish to gain a clear understanding of the essence of all present-day discoveries in the field of physics, will find this book of inestimable value.

C. K. S.

A Text-Book of Sound for B.Sc. Students. By R. N. Ghosh and R. N. Rai. (The Indian Press, Allahabad), 1940. Pp. 353. Price Rs. 5.

Advanced science text-books written by Indians to suit Indian conditions have been very rare in the past. It is fairly recently that the enterprising publishers of the present book started to remedy this defect by publishing the now well-known treatise on heat by Saha and Srivastava. This they followed up with Saha and Saha's *Modern Physics,* and other text-books have since been issued by the same firm. The present book is a welcome addition to Indian scientific literature, and is on the whole a praiseworthy attempt to put before B.Sc. students not merely a digest of older text-books but a good introduction to most of the modern developments in acoustics, both scientific and technical. The Calculus is sparingly used and the derivations of formulæ rest on a good discussion of the underlying physical principles. Occasional references to ancient Hindu ideas relating to the subject and some discussion of Indian music and musical instruments add to the value of the book. At the ends of some of the chapters brief biographical sketches of famous men of science who have enriched the subject of Sound have been given and photographs of some of these men enliven some corners of the book. The arrangement of the subject-matter is fairly logical but the many forward references to matters treated later on could reasonably be expected to be minimised. The get-up is good and the printing satisfactory, though we think Indian presses are capable of even better work. There is a large number of mistakes and misprints which require correction; we have made a list numbering about 60. Some faulty turns of expression such as: "we have described above the ear," "Aircrafts," "experiments were carried in a room," "cause the diaphragm to vibration," etc., incorrect spelling such as: "Tympanium," "Stethescope," "Kriger Menzel," "Tortional," "Aelian," "Whetstone bridge," etc., and some wrong statements like "10 micro-watts or 100 ergs," $\frac{"(\cdot 0002)^2}{40}$ ergs $= 10^{-16}$ watts," "g = force due to gravity," etc., require immediate correction. The matter included in the book, though highly interesting, may prove too much for adequate treatment in a B.Sc. class. But much of it may safely be left to the student himself to master, since the presentation is usually simple. In fact the book may be warmly recommended for the use of B.Sc. students; it really and adequately fills a lacuna that existed in the scientific literature available to Indian students.

T. S. SUBBARAYA.

The Manufacture of Compressed Yeast. By F. G. Walter. (Chapman & Hall, Ltd., London), 1940. Pp. viii + 254. Price 15*sh.*

The commercial production of compressed yeast, an organism known to man for ages, is one of the brilliant achievements of applied science. To the man of pure science, this little, microscopic, unicellular organism, had offered one of the most fruitful and fascinating fields of scientific endeavour. Year after year, there has been a steady and ever-increasing stream of contributions to our knowledge of this organism.

Yeast has given mankind not only the time-old and exhilerating liquors but has revealed to the scientific investigator that it constitutes one of the richest sources of enzymes, vitamins and other fine biochemicals. Recent work has established the virtues of yeast therapy in the prevention and cure of some of the major deficiency diseases.

Thanks to these discoveries, the yeast, to-day, has attained the dignity of a commercial product and constitutes the principal raw material for a number of vitaminised foods and fine chemicals.

The volume under review is a contribution to the applied science of yeast

manufacture. The author has presented a comprehensive description of the various methods employed in the cultivation of yeast. The fundamental principles involved in each of the processes—mashing, wort making, aeration, etc.—are discussed and their application to large-scale practice illustrated.

The raw materials and their conversion into yeast foods and methods of enriching them, are described in a manner, extremely helpful and suggestive to the manufacturer. The author has given a description of the plant and for the more important units, the constructional details are presented.

This is an extremely useful and highly practical volume; yeast is a crop of great economic value to the community providing as it does, a rich and inexpensive source of an important class of vitamins, which might be employed for enriching and fortifying the vitamin-deficient diets of this country. India has the necessary raw material for the manufacture of compressed yeast, in the form of molasses. Those interested, in the conversion of molasses into a useful product, will find this volume indispensable.

M. S.

A Text-Book of Zoology. By T. J. Parker and W. A. Haswell. Sixth edition. Vol. 2. Revised by C. Forster-Cooper. (Macmillan & Co., Ltd., London), 1940. Pp. xxiii + 758. Price 36*sh.*

With the growing need for a more up-to-date knowledge of Zoology, it was essential that the famous text-book known throughout the world as "Parker and Haswell" be revised and the first volume of the sixth edition of this work was reviewed in September last (*Curr. Sci.*, 1940, 9, No. 9, 425). A change in the contents as well as appearance was the natural result of this revision. The second volume (Chordata) follows the same plan. The type method of treatment for which the work has been so famous has been maintained and within the bounds of this general plan it has been possible to revise the text. And none better could have been found for this task than Dr. C. Forster-Cooper, who, by virtue of his position as the Director of the British Museum (Natural History) was most eminently suited to undertake it. It is clear that Dr. Forster-Cooper has been hampered by the limitations imposed on him by the general plan of the original work whose form he had to maintain and which has clearly imposed on him a restriction of scope as well as of method. But for this, Dr. Forster-Cooper's work would have been even greater. But then, it would not have been "Parker and Haswell". He has however, boldly excised from the book the chapters on geographical distribution, Philosophy of Zoology, History of Zoology and such general considerations. It would have, for one thing, been impossible to condense these into the very little space available; for another, while there are a number of recent books dealing with the above subjects which place these general topics within easy reach of the student for whose standard "Parker and Haswell" is meant, no useful purpose would be served by incorporating these voluminous theories into a text-book. This has made "Parker and Haswell" a strictly morphological treatise, and that, we believe, was the original intention of the authors.

The first striking change that meets the eye of the student is the newer schemes of classification adopted in the book. Nothing causes more annoyance and confusion to the young mind than the diversity of nomenclature and classification that is met with in zoological treatises, some incorporating new ideas in classification, others fighting shy of them and retaining the old ones. It is here that a popular, useful and established text-book like "Parker and Haswell" can pursue as well as set a definite policy in the matter of the adoption of newer schemes of classification for lesser books to follow. Dr. Forster-Cooper has done this with distinctive success and it is hoped that much of the confusion caused by the multiplicity of the schemes will be dispelled.

Detailed considerations of Palæontology of vertebrates too would occupy too much space and would unnecessarily overburden the text and even here, newer publications specially devoted to this branch of study could easily be consulted by the interested student. This is especially so with regard to the extinct groups of fishes, reptiles and mammals whose forms are so many and so varied that not to deal with all or most of them would amount to not dealing with any of them. But Dr. Forster-Cooper has utilised our knowledge of these groups to summarize the present position regarding their interrelationships. The agnathous fishes have been dealt with at length and the number of recently described fossil forms have been treated in detail, because they form, for a clear understanding of the fishes

in general, a perfect introductory note. The classification of fishes has been revised and brought up to date.

Much light has recently been thrown on the structure of the skull of reptiles, both extinct and modern, and the temporal region of the skull provides the key for a correct understanding of the phylogeny of the group. In a series of diagrams drawn specially for the book, Dr. Forster-Cooper has shown the relative arrangement of the different bones of the skull in the several orders and has traced the ancestry of the avian and mammalian temporal regions. The lower jaw of the fossil reptiles is another feature which has lent itself for a discussion of the ancestry of higher vertebrates and Dr. Forster-Cooper has summarized our knowledge of the structure and phylogeny of the reptilian lower jaw.

The treatment of birds has not undergone any considerable change and in fact the rather limited scope of the work has precluded the consideration of the varied natural history and the diverse adaptations of these animals and the student is referred to one or the other of the numerous books on the subject. But, we ask, is any treatment of birds complete without an account of their migration, their parental instincts and their marvellous adaptations to different modes of life? In our opinion the book is the poorer for the exclusion of these interesting facets of bird life.

Mammals have received wide attention at the hands of the reviser. The young student's heart will jump at the enumeration in serial order of the characters of the typical mammal. A very detailed account of the Prototheria and Metatheria presents the salient features of these groups and provides the student with adequate information regarding these two zoologically interesting sub-classes.

In the classification of the mammalia the fossil groups like Allotheria, Triconodonta, Symmetrodonta and Pantotheria have been included along with the modern forms and brief descriptions of them have been incorporated in order to present an idea of the ancestry of the modern mammals. In fact the entire treatment of the mammalia is based on the underlying idea of the appearance in time of its different classes and presents a variation over that of the older editions. Thus the former Ungulata Vera is replaced by the Perissodactyla and Artiodactyla each of which has a different ancestry and each of which has been treated as an independent order.

The format of the book also has changed for the better. The page size is larger and so is that of the types. A wider spacing of the lines presents a better appearance and makes for easier reading. The addition of over a hundred figures has been necessitated by the augmented text. The reviser as well as the publishers are to be congratulated on the production of a useful and attractive edition of this famous book.

B. R. S.

Energy and Economics—A Plea for a New View-Point. By Gilbert J. Fowler, D.SC., F.I.C., F.R.San.I., F.N.I. (The Times of India Press, Bombay). Price 12 annas or 1*sh.*

To readers of *Current Science* this interesting brochure may present many familiar features. Dr. Gilbert Fowler in republishing the article originally contributed to this *Journal,* has furnished an "Introduction", two appendices and a supplementary bibliography relating to the subject of Energy and Economics. The Introduction, which summarises the views on the subject of a "new order" in the economic sphere, provides the most stimulating reading. It is obvious that in our society the unemployed, in the first place, are the scapegoats of an organisation which is unable to incorporate technical progress into its general social frame-work. For mechanical progress does not necessarily signify social progress. When society is thoroughly reorganised, economically and psychologically, and can keep pace with the advance of industry, is continuous improvement possible. Efforts must therefore be made to influence men to think ahead, to maintain the courage and sense of adventure which are so successfully used in the realms of service for the welfare of society. Dr. Gilbert Fowler has the faculty of thinking far ahead of his generation, and though his ideas for the economic betterment of society may at the present moment seem unorthodox, they are bound to create a general reformation in our concept of "money", "wages", "credit" and "production" which now under the influence and power of the financier, underlie all social unrest and upheaval. On page 8, there is a courageous and truthful utterance against the "money power", of England, in contrast with the German system of basing credit on the energy of the people. "It is here that the

world of science must be awakened." After all the problem of finance cannot remain long without being "brought within the domain of science or fundamental truth". "To a scientific thinker it seems absurd that the reward of any worker, be he a statesman or a scavenger, should depend on anything other than the value of his labour to the community." We agree with Dr. Fowler when he says that the solution for the social evils lies in the community control of money credit and interest and that no single individual or institution should be permitted to "affect the fortunes favourably or unfavourably of thousands of people," by "a simple manipulation of the currency". After a very careful and critical analysis of the affairs of men and money, Dr. Fowler announced the idea of the ERN, which he has elaborated in a series of articles distinguished alike for their clearness of thought and cogency of argument. "It is a definite measure of potential man power,—the daily nitrogen ration of an average human being with its equivalent energy, *i.e.*, 10 grams of nitrogen and 300 calories of energy." Ultimately the world is bound to get rid of the tyranny of "money" and to adopt an international currency unit which would settle once and for all those factors which militate against our social and spiritual progress. Dr. Fowler has found the way. We must have the needful vision and boldness to tread that path—the path of fundamental truth.

Experiments for the Haveli Project on a model of the rivers Jhelum and Chenab downstream of their confluence. By Dr. N. K. Bose and L. Thakar Dass Gulati. (Punjab Research Institute Research Publication), 1940. Vol. II, No. 24. Pp. 58. Price Rs. 1–8.

Before undertaking the construction of the Emerson Barrage across the river Chenab, experiments were conducted on a model of the rivers Jhelum and Chenab downstream of their confluence with a view to investigate the best orientation of the weir at the proposed site, the best position and shape of the guide banks, leading diversion cuts to the weir and the height of training works and embankments.

The model was built to a horizontal scale of $^1/_{300}$ limited by the available land at Malikpur and to a vertical scale of $^1/_{50}$. A time scale of 10 min. = 1 month was found to give the best reproduction of the 1936 cross-section starting from the 1915 cross-section, when the model was run with different discharges based on a discharge curve prepared by taking ten-day averages from hydrographs of the two rivers from the year 1922 onwards. Silt of the same grade as in the river was injected, half a cubic foot of silt for floods bigger than 150,000 cusecs and quarter cubic foot for floods between 80,000 and 150,000 cusecs and no silt was injected for lower discharges.

Experiments were conducted to study the behaviour of the river during the construction, diversion and post-diversion periods. During the construction period run, the right outside ring between the weir site and the main river was attacked by the river during heavy flood and a radial spur was put in to protect the bund.

A retired embankment was thrown across the river and leading cuts were introduced upstream and downstream of the weir. The model was run for 5 years corresponding to 1939 to 1943—the discharges being those of 1929 to 1933. After the run, the river downstream of the weir was found to follow its old right-hand course. The right guide bank was undermined at the upstream and downstream noses. The main stream struck the weir centrally, passed around the noses of the divide walls undermining them and carried silt into the pockets and finally into the canal. Belas were formed on the inside of the right guide bank upstream of the right divide wall and in the right river pocket.

The right guide bank was modified and turned round to control the bela formation. In the next diversion run the mainstream was led through a cut 300 feet wide, cuts leading to the centre of the weir and to the sluices were each 150 feet wide and the downstream cuts were all 300 feet wide. The model was run as before for five years corresponding to 1939 to 1943. During this run, the left-hand branch of the river downstream of the weir and the right-hand branch above the weir developed, the bela formed in the previous run almost disappeared and there was no scour at the nose of the right divide wall. There was a deep scour at the nose of the left divide wall due to the main current entering the pocket from the right of the divide wall, instead of directly into it. This defect due to the river approaching the weir at an angle could be overcome by turning the weir-line through 10° to 15° about its right

end till the left end was moved upstream to the nose of the left divide wall when the weir would be normal to the main stream with the pockets getting a straight current.

The construction of the Emerson Barrage was started after the above experiments were carried out. Model experiments not only indicated a suitable design but prevented the adoption of faulty designs entailing possible future expenditure on protective and remedial measures.

C. GOPALAKRISHNAN.

AGRICULTURE IN AFGHANISTAN

WE owe the following brief summary of the agricultural features of Afghanistan and of the directions in which development is possible to extracts from the report of the Indian Agricultural Delegation which visited that country in the year 1939. The area fit for cultivation is said to be less than a quarter of the total extent of the country which is 270,000 square miles, mostly mountainous in character. The average height is about 3,000 feet and the central valleys are over 6,500 feet above sea-level. The rivers flow through deep gorges, are snow fed and liable to sudden spates. A peculiarity of these rivers is that as they get farther from their sources they dwindle away and get lost in the soil. The average annual rainfall including snowfall is only between 12 and 15 inches and in certain places no more than 2½ inches. The climate varies between an Alpine one in the north-east to a hot desert one in the south-west. The soils are on the whole fertile and under irrigation yield an abundant harvest. Irrigation is from streams, springs and from what are called "kerezes". The inhabitants are engaged mostly in agriculture and pastoral pursuits.

It is as a fruit-growing country that Afghanistan has impressed the Delegation and many useful suggestions are given for developing this industry on proper lines. These relate to the introduction of citrus fruits and of loquats, figs, and canning peaches, of better varieties as regards both quality and yield, of improved planting methods and pruning and to the control of insect pests and diseases. Improvements in propagation methods are indicated with special reference to suitable stocks from East Malling and elsewhere. Alongside of the fruit-growing industry is stressed the need for developing the fruit-products industry and for this purpose a fruit products laboratory is recommended to be opened under Government auspices. Among other crops, cotton has made great progress, the staple is suited for 60 counts and the crop is remarkably free from diseases and pests. Sugar beet is extensively grown and a beet sugar factory is under construction. Its progress will depend upon the extent to which diseases can be kept under control. Wheat is the most extensively grown crop but it is subject to both rust and smut; the breeding of higher yielding and disease-resistant types is recommended. Large tracts are under rice and the Delegation thinks that the area may be reduced and money crops like cotton, tobacco, fruit, etc., may be substituted. Experiments with a view to establishing the cultivation of cigarette tobacco are suggested and an increase in the cultivation of potatoes is recommended especially because the cold climate will enable the country to meet the large Indian demand for both seed and table potatoes admirably. Artemesia is growing wild and an examination of its quality as a source of santonin is suggested. As mulberry grows extensively in the country the development of sericulture forms another recommendation. Likewise attention is drawn to the introduction of the bee-keeping industry both as an aid to fruit cultivation and as an independent source of income. The cultivation of berseem is desirable for fodder and green manure and also as a source of seed supply to India. Irrigation, artificial manures, and improved implements are briefly touched upon, with a keynote of caution. The Delegation on the whole has been so greatly struck with the agricultural possibilities of Afghanistan as to observe that "Its agricultural potentialities are immense" and that "it is round agriculture that the future prosperity and well-being of the country will revolve".

A. K. Y.

CENTENARIES

Dewees, William Potts (1768–1841)

WILLIAM POTTS DEWEES, an American obstetrician, was born May 5, 1768, near Pottstown, founded by his maternal grandfather, Thomas Potts. After school education, he studied medicine in the University of Pennsylvania from 1787 to 1789 and became M.D. in 1806 on the basis of his thesis *An essay on the means of lessening pain and facilitating certain cases of difficult parturition.* He began private practice in 1790.

At that time obstetrics had not received attention from the profession and the majority of deliveries were in the hands of midwives. Nor was there any formal teaching in the subject. There was a strong prejudice against 'men midwives'. Indeed Laurence Sterne's picture of Dr. Slop in *Tristram Shandy* is an index of the derision to which the man midwife was subjected. In spite of it Dewees had the courage to teach the subject and practise it. Very soon he became popular and it is said that he delivered over ten thousand women.

By and by, public opinion veered round and a professorship of obstetrics was created in Pennsylvania. But a less competent rival of Dewees was preferred. This and other disappointments shattered his health and tuberculosis developed. Hence he gave up practice and took to agriculture at Phillipsburgh. Though this venture proved a failure, he regained his health and resumed practice in 1817. He was also made additional professor in 1825. After he became chief professor in 1835 and thus realised his frustrated ambition, he developed cerebral hemorrhage and had to resign his professorship.

His chief work was *A compendious system of midwifery,* which though published posthumously, went through twelve editions. He also published volumes on gynæcology and general medicine.

Dewees died at Philadelphia May 20, 1841.

Radcliffe, William (1760–1841)

WILLIAM RADCLIFFE, a British textile inventor, was born October 17, 1760, at Mellor, Derbyshire. His father being a weaver, he learnt carding, spinning and weaving at home and began business in his own village. Later in 1801 he settled at Stockport. He opposed the export of yarn to the continent on the ground that it deprived local weavers of their vocation. On this he published in 1811 a pamphlet entitled *Exportation of cotton yarns the real cause of the distress that had fallen upon the cotton trade for a series of years past.*

With the help of one of his mechanists, he invented the 'dressing machine' by which the warp could be dressed or starched before being put into the loom. This and other inventions of his resulted in the saving of much time. But the great expense he incurred in his experiments ruined him and he became bankrupt in 1807.

With the help of some friends, he again started business; but broke down again in 1815. His life was thereafter one of adversity. In 1820 he published an account of his struggles under the title *Origin of the new system of manufacture commonly called power-loom weaving, and the purposes for which this system was invented and brought into use fully explained.* Efforts were made in 1825 to secure a parliamentary grant for him on the ground that his invention "by removing the impediments to weaving by power, may be considered as the cause of rapid and increasing growth of that system of manufacturing cotton goods". They did not then bear fruit. Several firms however gave him a royalty and ultimately a small grant of £150 was made by government. But the intimation came only three days before his death, which took place May 20, 1841.

S. R. RANGANATHAN
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SCIENCE NOTES AND NEWS

Photo-Fission of Uranium and Thorium.—Hahn and Strassmann's discovery of the neutron-induced fission of uranium atoms resulting in two fragments of nearly equal masses early in 1939 was quite a sensational piece of scientific news. Scientists were therefore well prepared in 1940 for the preliminary announcement from the Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania, that uranium and thorium atoms behaved similarly under the influence of energetic γ-rays. The discoverers of this phenomenon of photo-fission, R. O. Haxby, W. E. Shoupp, W. E. Stephens and W. H. Wells have recently (*Phys. Rev.*, 1941, 59, 57) given a fuller account of their findings. High energy protons (2–3 Mev.) from the Westinghouse electrostatic generator were, after magnetic analysis, directed on to a CaF_2 target in a Faraday cage. The bombardment of fluorine gave rise of γ-radiation of the required energy (about 5 Mev.), which in turn irradiated a 12 cm.^{2} piece of uranium metal, placed on the high voltage plate of the ionisation chamber. The authors have thereby measured the cross-sections for the photo-fission of uranium as well as thorium and find that

$$\sigma_U = 3{\cdot}5 \times 10^{-27} \text{ cm.}^2 \text{ and}$$
$$\sigma_{Th} = 1{\cdot}7 \times 10^{-27} \text{ cm.}^2,$$

with a probable error of about 30 per cent. The fission of the heavy nucleus is thus not a frequent happening. The chance that one quantum of γ-rays per cm.^{2} will cause the fission of one atom of uranium is $3{\cdot}5 \times 10^{-27}$. Under comparable circumstances, the cross-section of the uranium atom for fission by slow neutrons would be about 3×10^{-24} cm.^{2} Thus the neutron-induced fission is roughly 1,000 times as probable as the photo-fission. These recent experimental values for the cross-sections in photo-fission agree well with the theoretical estimates by Bohr and Wheeler.

L. S.

Electrostatic Generator and Transmutation of Fluorine.—In the February issue of the *Physical Review* (1941, 59, 241) Tom Lauritsen, C. C. Lauritsen and W. A. Fowler have published the details of construction of a pressure electrostatic generator that they have erected in the Kellogg Radiation Laboratory of the California Institute of Technology, Pasadena. A brief review of the details of this generator with the diagrams (reproduced by permission) has been attempted in the columns of *Current Science* (1941, 10, 124) by C. K. Sundarachar, J. F. Streib and B. V. Raghavendra Rao. Complete details regarding the design of the generator, the high potential electrode, the pressure vessel, the supporting and insulating columns, the charging system, the ion source and the accelerating tube are now directly available from the Kellogg Laboratory for those interested in the construction of a similar generator in India. The dependence of the terminal voltage on the charging current as well as the relation between the maximum operating voltage and the tank pressure have been studied. The performance of this generator which operates at 1·7 Mv. in a cylindrical tank of over-all length 13′ 6″ and diameter 8′ at a pressure of 80 lb. per square inch is discussed. The transmutation of fluorine by protons accelerated to high velocities by the generator has been examined by J. F. Streib, W. A. Fowler and C. C. Lauritsen (*Phys. Rev.*, 1941, 59, 253). The origin of the γ-rays given off when fluorine is bombarded by fast protons is traced to the reaction

$$F^{19} + H^1 \rightarrow {}^{\gamma}Ne^{20} \rightarrow {}^{\gamma}O^{16} + He^4$$
$${}^{\gamma}O^{16} \rightarrow O^{16} + h\gamma,$$

where the superscript γ refers to states of Ne^{20} or O^{16} involved in the production of the 6·2 Mev. γ-radiation. The γ-radiation has been shown to exhibit resonance at proton bombarding energies of 0·334, 0·479, 0·589, 0·660, 0·862, 0·927, 1·335 and 1·363 Mev. thereby leading to a discussion of the nuclear energy levels of the intermediate products; the emission of the short-range α-particles has been definitely established.

L. S.

The Growth and Food of Young Salmon.—An account of the growth of Salmon based on observational data in 220 Salmon smolts and parr captured during a period of 8½ years has recently been published by Went (*Proc. Roy. Irish Acad.*, 1940, 46 B, 53). Of the specimens collected, males comprised 62·8 per cent. and of these, 46·5 per cent. were sexually mature. Some smolts of the two-year class which showed signs of rapid growth migrated first, showing that the migration of smolts depends on some physiological condition which is associated with the attainment of a minimum size. The Salmon grew less rapidly than the brown trout and the scales indicated that the "Summer" or rapid growth was from April to end of July. Careful observations have revealed that it would be impossible to use the scale method for determining the proportion of sexually mature fry or to say from the adult scales whether the male had spawned during its parr life.

In the same paper, Frost has reported on the food contents of 192 Salmon parr and smolts ranging in length from 9 to 18·5 cm. Different age groups showed no significant differences except that the larger Salmon ate winged Ephemeroptera. As the trout feeds mostly on aquatic insect larvæ the author suggests that in the River Liffey the competition for food between the Salmon and trout will chiefly be for these larvæ.

R. G.

The Marketing of Potatoes in India.—The report on the marketing of potatoes in India recently issued by the Agricultural Marketing Adviser to the Government of India maintains the high standard of thoroughness which we are now accustomed to associate with these marketing surveys and reports. It deals with

the subject on the comprehensive plan which has now been standardised for these reports, all the main aspects of supply, demand and distribution being fully examined and reported upon and suitable recommendations for improvement under all heads also made. The total annual production of potatoes in India is reported to be 491 lakhs of maunds worth about nine and a half crores of rupees. There is in addition an import of 11½ lakhs of maunds worth over Rs. 33 lakhs. The area estimated as 448,000 acres is concentrated in the United Provinces, Bihar, Bengal and Assam, which together account for 80 per cent. of the acreage. About 90 per cent. is grown in the plains and the remainder on the hills; the former being mainly a winter grown crop and the latter summer grown. One of the most important problems is that relating to the storage of the produce over some months for its sale as table potatoes and as seed. The loss in the present methods of storage and handling is enormous and its money value is estimated at over a crore and a half of rupees. Prices at harvest time are only Rs. 1–8 to Rs. 2–8 a maund but they soar to Rs. 5 to Rs. 14 per maund after six months—a fact which shows the advantage of storage and the need for preventing the deterioration and loss. Much of the imports are for seed purposes and the high price of seed imported or locally grown and stored as compared with the price of ordinary produce is one of the heavy handicaps to potato cultivation. The subject of storage methods including cold storage is gone into as fully as its importance deserves. Railway transport charges are said to be very high and the use of the ordinary steel waggons leads to damage in transport; a reduction in the tariff of charges and the substitution of wooden vans for steel ones are suggested. The formation of co-operative societies of growers for the joint purchase of seed, and for looking after the financial and other needs of the members is recommended. Regulated markets, standardisation of weights and measures and the grading of potatoes according to sizes, shapes, colour and quality as well the use of standard forms of packages, and finally, on the side of research, the production of varieties with better keeping qualities, shorter periods of growth and of dormancy, disease-resistant and high yielding are among the many other useful recommendations. A. K. Y.

Flora of the Punjab Plains.—An account of the Flora of the Punjab Plains and the Associated Hill Regions has been recently published by Dr. T. S. Sabnis (*J. Bombay Nat. Hist. Soc.*, 1940, 42, 124–49). In preparing this compilation, the author has obtained much useful information from the published papers of previous workers on the floras of the Punjab and from an examination of the collections in the Herbarium of the Forest Research Institute, Dehra Dun. The contribution refers only to a part of the flora of the Punjab plains and associated hill regions. According to Dr. Sabnis the Punjab flora "represents 118 families which include 530 genera and 949 species" while actually the number of families, genera and species listed in the paper are 39, 105 and 189 respectively. The reason for this discrepancy is not clear. Further in numbering the families, No. 13 has been missed so that the total number of families described is 38 and not 39. Dr. Sabnis's contribution on the flora of the Punjab plains, etc., is incomplete in that such important families of the dicotylednæ as Compositæ, Convolvulaceæ, Acanthaceæ, Euphorbiaceæ and others are omitted. Not a single monocotyledonous family is included. We trust that this discrepancy will be made up by the publication of a supplementary list.

L.S.S.K.

Indian Vegetable Oils as Fuels for Diesel Engines.—The annual production of vegetable oils in India is about eight million tons. Although at present the market prices of vegetable oils are in general higher than that of mineral Diesel oils, in certain localities, particularly the non-edible oils are available at fairly cheap rates, and it is quite probable that at a not too distant future, the relative prices of the vegetable and mineral oils may be reversed. It is therefore of great national importance to investigate the utilisation of vegetable oils as Diesel engine fuels. The results obtained by the Indian Research Bureau indicate that most of the vegetable oils may be successfully employed as Diesel fuels (*Bull. Ind. Res. Bureau*, 1940, No. 19. By H. D. Chowdhury, S. N. Mukherji, J. S. Agarwal and Lal C. Verman). Some do not require any modification in the engine except minor adjustments; such oils include groundnut oil, cotton seed oil, and rape seed oil. Cotton seed oil gives an exceptional performance in that its consumption is definitely less than that of mineral oils, and its efficiency appreciably higher, while the power output is equal to that obtained in the case of mineral oil.

The Indian Glass Industry.—With an annual production valued at Rs. 2,00,00,00,000 India's 101 glass factories are now able to meet national requirements to the extent of over 50 per cent. of the annual consumption. This figure may rise rapidly as further results of industrial research are made available to the industry.

The Board of Scientific and Industrial Research is further considering improvements in the furnaces designed at the suggestion of the former Industrial Research Bureau. As a result of stimulus given by the Bureau, a number of firms began to manufacture and market China glass. The possibilities of manufacturing liquid gold were indicated in a Bulletin of the Bureau (Bull. No. 17).

Good neutral glass is now being manufactured in Calcutta and satisfactory laboratoryware is now being produced. The requirements of the pharmaceutical industry and the medical services would soon be met by the glass produced in the Indian factories.

With the introduction of modern methods, new lines of manufacture are now open, such as beads, false pearls, ornamental glass plates, lampware, phials and tableware. The Glass and Refractories Committee of the Board of Scientific and Industrial Research is investigating the

production of optical glass and already certain samples have been prepared which have been reported to be fairly satisfactory especially for making binoculars and lenses.

Archaeological Survey of India.—In the field of exploration the most important discovery was that of a colossal temple with multiple terraces and angles datable to the early centuries of the Christian era at Lauriya Nandangarh in Bihar, says the *Annual Report of the Archæological Survey of India for the year* 1936–37 just published. This temple is the earliest prototype of the architecture of Burma, Java and Siam. The work was carried out by the late Mr. N. G. Majumdar, whose premature death has deprived Indian archæology of a devoted explorer.

A number of ruins were also explored in the jungles of Assam, which still hold some surprises for the archæologist.

During the year under report the Gol Gumbaz at Bijapur, the biggest dome in India, was reconditioned and special repairs to Taj Mahal at Agra, the Imambara of Asaf-ud-Daula at Lucknow and the ancient Buddhist ruins at Sarnath near Benares were carried out.

In the epigraphical branch the most important discovery is that of the earliest inscriptions found with three Barhmi inscriptions from Kosam, ancient Kausambi in the Allahabad District, one of which dates from the second Century B.C. Much material was collected in Central India, Rajputana and South India. A specially important feature of this year's collection is the discovery of a number of copper-plate records which throw interesting light on the history of early and mediæval India.

In the field of Museums, great improvements were recorded in the acquisition and re-arrangement of departmental museums. A detailed scheme whereby a number of museums in all Provinces throughout the country should benefit by receiving duplicate representative sets from Mohenjodaro was launched during the year. This work has been steadily going on and is much appreciated by the authorities in charge of the Provincial Museums.

Botanical Survey of India.—The collection and dissemination of all available information regarding several plants of economic importance; a thorough study of the possibilities of cultivating ipecac; the development of the tung-oil industry and the use of water-chestnut as a food product are among the activities referred to in the Annual Report of the Botanical Survey of India for the year 1939–40.

Nearly 3,500 specimens were identified and revised during the year; of these about 800 plants belonged to the Forest Research Institute, Dehra Dun, and 702 Burmese specimens were received from Dr. E. D. Merrill of Harvard University, U.S.A. The rest were sent by various Government Departments and educational institutions and private workers in India and abroad.

A large number of exhibits has been added to the already rich collection of specimens in the public gallery of the Industrial Section of the Indian Museum. Among them are Indian silk products, industrial oils and oilseeds, food products, plant specimens of reputed insecticidal properties, hand-made paper exhibits and medicinal plant products.

Both the Herbarium and the Library have been enriched by new collections and acquisitions of suitable literature.

Workers in universities and other institutions both in India and abroad were supplied with different plant materials for their research work and the results obtained were in most cases communicated and recorded.

Correspondents, mainly from the commercial public, were supplied with information on the sources and supply of economic plant products, such as fibre, resins, tanning materials, varnish oil, vegetable dyes, insecticides and medicinal plants.

Imperial Veterinary Research Institute.—The Annual Report for the year 1939–40 issued during this month draws attention to the expanding activities of this institution, which not only provides facilities for research in veterinary science but also provides instruction to post-graduate students in advanced animal husbandry including poultry husbandry. Arrangements have been made to set up a central museum at Izatnagar with a view to give the visitors a scientific insight into the field now covered by veterinary science. It is also proposed to establish a Wool Research Laboratory and a laboratory for investigating problems connected with hides and skins.

The Poultry Research Section of the Institute at Izatnagar has been the central agency for promoting interest in poultry farming by research, advisory work and instruction to students. In this section, long-term breeding and nutrition experiments have been started. Of the poultry diseases studied, mention may be made of Fowl *spirochætosis* and infection with *Sp. anserina*. Birds infected with the latter, have been successfully treated with atoxyl.

In the Animal Nutrition Section surveys of animal nutrition in villages have been conducted. The examination of cattle feeds suitable for famine areas and experiments on the drying of grass, etc., are being carried out. The study of the more common cattle diseases including rinderpest was continued. It was observed that the vitamin C content of tissues of animals was greatly reduced in certain diseases like rinderpest, worm infectation (in horses), etc. As farm animals are known to be capable of securing their own vitamin C requirements, independent of the diet, this observation is of particular interest. The problem is being investigated in detail.

The spore-vaccine issued by the Institute for the treatment of anthrax has proved very successful; animals treated with the vaccine proved immune for at least 18 months.

Industrial Research Bureau: Annual Report, 1939-40.—The achievements of the Industrial Research Council, the Industrial Research Bureau, and the Research Branch of the Government Test House, Alipore, are briefly summarised in this report. We notice that the

Industrial Intelligence Service is being increasingly availed of, and is forming a very useful activity of the Industrial Research Bureau. The principal subjects of research of the Research Branch of the Government Test House have been the improvement of paints, manufacture of dry cells, and the utilisation of Indian vegetable oils as lubricants and as fuels in internal combustion engines. Brief accounts of the progress in these as well as in a number of other subjects are given in Chapter III.

Department of Industries, Bombay.—The Annual Report for the year 1939–40 (obtainable from the Superintendent, Government Printing and Stationery, Bombay, price As. 5), indicates that the new industrial joint-stock companies floated during the year under review involve a capital of nearly Rs. 340 lakhs. Among them is a new factory for the manufacture of starch from maize with a capital of Rs. 25 lakhs, under construction in Ahmedabad. This factory also proposes to manufacture glucose, dextrine, chemical starch, gluten, food maize, germ oil, etc. It is also interesting to note that a leading American firm has invested Rs. 75 lakhs for the manufacture of car and cycle tyres, using Indian raw materials.

The Department has, as usual, vigorously helped in the solution of practical difficulties encountered in the process of manufacturing and marketing the goods of a variety of Industries in the Province, and has conducted experimental industrial work and practical demonstrations for the benefit of small-scale and cottage industries.

Prince of Wales Museum of Western India.—The Annual Report for the year 1939–40 just issued, records the activities of the Art, Archæological and Natural History Sections of this most important National institution. Several improvements have been effected in all the sections with a view to render the Museum more useful both for public instruction and research.

In consultation with expert opinion the Trustees took all necessary precautions for protecting the most valuable exhibits from possible war damage. With a view to establishing a closer co-operation between the Museum and general public and schools, it is proposed to appoint guide lecturers.

In the exhibition of arms and costumes a new and attractive feature has been introduced in the Art Section on the model of the Folk Museums of Scandinavia. Models of Mughal and Maratha officers and soldiers have been prepared in the Art Section, and are being equipped with offensive and defensive weapons of the seventeenth century and dressed with the costumes of the period. In the Natural History Section numerous models illustrating the structure of reptiles have been prepared and suitably exhibited.

Post-graduate students of the Deccan College Research Institute and other scholars were given full facilities for the study of the exhibits in the Prehistoric and Brahmanical galleries of the Archæological Section. In the Natural History Section the work of cataloguing and arranging the research collections was continued and the reference collections of reptiles and fishes were made available to Drs. Malcolm Smith and S. L. Hora, who are now engaged on a revision of the Fauna of British India (Reptiles and Fishes).

Pasteur Institute of Southern India, Coonoor.—The Annual Report of the Director for the year 1939–40 which was issued early this year, gives an account of the rapidly expanding activities of this Institute. In addition to the usual routine work, much valuable research on rabies was carried out. A notable achievement is the preparation of a clear vaccine of high immunising value obtained by the iso-electric precipitation of a large quantity of inert protein accompanying the phenol-vaccine now in use. The preparation was relatively non-toxic.

A research unit known as the Protozoal Parasites Enquiry was attached to the Pasteur Institute, Coonoor, at the end of 1938. This unit is entirely financed by the Indian Research Fund Association. The activities of this section include, the study of the mechanism of defence against malaria, the study of antibodies in the spleen and the peripheral blood of immune monkeys, and large-scale experiments with sporozoites of *P. gallinaceum* (undertaken in collaboration with the Malaria Investigations of the International Health Division of the Rockefeller Foundation working at the Pasteur Institute, Coonoor). Several new species of protozoal parasites have been encountered during the progress of the enquiry. A hitherto undescribed species of *Plasmodium* has been observed in the blood of Malabar squirrels but all attempts to transmit this parasite to other animals by blood inoculation, or to obtain a suitable insect vector, have so far failed. This work has received special attention since it is highly desirable to procure a malarial infection in some small laboratory animal. A trypanosome infection has also been discovered in the blood of the Malabar squirrel. Natural infection with a malaria parasite believed to be *P. inui* has been found in the blood of a young specimen of *S. sinicus* originating in the foothill jungles within 15 miles of Coonoor. This is the first record of this parasite in India.

Other independent units working in the Pasteur Institute are: Nutrition Research Laboratories (financed by the Indian Research Fund Association), Malaria Investigations (financed by the International Health Division of the Rockefeller Foundation) and Plague Enquiry in the Nilgiri District. The Pasteur Institute has recently carried out successful experiments on the preparation of precipitin sera for human and ox blood, as there is a considerable demand in the East for such high titre precipitin sera for the detection of blood meals taken by mosquitoes.

With a view to revive industries on vegetable dyes the **Board of Scientific and Industrial Research** has set up an exploratory committee on vegetable dyes.

As a result of the encouragement given by the Board, much useful work has already been

carried out. Work on the dyes from Kamala flowers, for use as edible colouring materials, has been completed at the H. B. Technological Institute, Cawnpore. The possibility of producing dyes from myrobalans is being studied under the auspices of the Mysore University. Experiments have been completed at the Government Textile Institute, Madras, on some natural die-yielding products of indigenous growth, the use of which was in vogue prior to the advent of synthetic dyes. The process of extraction of the colouring matter has been standardised and recipes for several shades for use with cotton, silk and wool have been drawn up.

The American Academy of Arts and Sciences has awarded the **Amory Fund** of nearly $16,000 to four investigators in consideration of their outstanding contributions to the treatment and cure of diseases of the genito-urinary system. The name of the three American recipients, announced in *Science* are: Dr. Joseph F. McCarthy, Dr. Carl Richard Moore, and Dr. Hugh H. Young. The name of the fourth recipient, who is in Europe has not been made public and his prize will be held by the Academy in trust.

The Amory Fund was established in 1912. The income for the Fund is devoted to the award of a septennial prize and the prizes just awarded are the first awards from the Fund and cover the contributions made since 1933.

The Katherine Berkan Judd Prizes of $1,000 have been awarded to Drs. E. L. Kennaway and J. W. Cook of the Royal Cancer Hospital, London, for "outstanding contributions to knowledge of the cause and cure of Cancer" for the years 1939 and 1940. Dr. Kennaway isolated dibenzanthracene in crystalline form from coal tar and showed that it was active on all animals in the causation of cancer. The structural formula of the causative agent was worked out by Dr. Cook.

Imperial Agricultural Research Institute.—The Diploma of the Institute (Assoc. I.A.R.I.) has been awarded to Mr. P. R. Bhagwagar, M.Sc. (Alld.), after the completion of two-year post-graduate course in Mycology and Plant Pathology, and in consideration of his thesis entitled: Part I—*Review of Fungicides in India* (including Burma and Ceylon). Part II—*Studies in* Fusarium *Wilt and Seed-rot of Gram* (Cicer arietinum *L.*) *in India.* Part III—Alternaria *Species on Potato in India.*

Andhra University.—The Honorary Degree of *Doctor of Science* has been conferred on Rao Bahadur T. S. Venkataraman, Imperial Sugarcane Expert, Coimbatore, and on Prof. S. Bhagavantam, Professor of Physics, Andhra University, Waltair.

The Executive Council of the **Lucknow University**, at their meeting held on April 18, unanimously elected Kunwar Sir Maharaj Singh, Vice-Chancellor of the University. Sir Maharaj Singh will take over charge of the office on July 16.

SEISMOLOGICAL NOTES

During the month of April 1941 one great, five moderate and four slight earthquake shocks were recorded by the Colaba seismographs as against three moderate and two slight ones recorded during the same month in 1940. Details for April 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of Focus	Remarks
April 1941		H.	M.	(Miles)		(Miles)	
1	Moderate	16	11	6890			
3	Moderate	20	59	5210			
15	Slight	01	03	1210			
16	Great	00	40	9840	Epc: Near lat. 15° N., and long. 92° W., to the south-east border of Mexico		
18	Slight	10	53	3090			
18	Moderate	18	55	3090			
19	Moderate	13	24	2010	Epc: Near lat. 40° N., long. 97°·5 E. in the neighbourhood of Su-chow in Kan-Su, China		
20	Moderate	23	09	1420	Epc: Near lat. 39°·7 N., long. 75° E., near Kashgar in Sin-kiang, China		
27	Slight	04	41	1490			
30	Slight	15	16	4290			

ASTRONOMICAL NOTES

The Sun will be at the summer solstice on June 22, when it reaches its most northerly position.

Planets during June 1941.—Both Mercury and Venus will be low down in the western sky at sunset; the former attains its greatest apparent distance from the Sun (23° 47′ E.) on June 6 and can be easily seen as a reddish star of magnitude 0·6 during the first half of the month. Mars is in quadrature with the Sun on June 2. It is in the constellation Aquarius and will be visible as a red star very near the meridian at sunrise. Its stellar magnitude at the end of the month will be −0·4. The three planets, Jupiter, Saturn and Uranus, are all morning stars rising only a short while before the Sun and are not favourably situated for observation.

Omicron Ceti (Mira).—The next maximum brightness of this interesting variable is expected to occur about June 25, when the star is likely to be of the second magnitude. The position is R.A. 2^h 16^m, Declination 3° 15′ S. It is one of the best known of the long period variables, the range of variation being nearly eight magnitudes and period 331·8 days. The star is of a deep red colour, and at maximum, can be easily located as a bright second magnitude star a little to the south-west of the stars α and γ Ceti.

T. P. B.

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"Journal of the Royal Society of Arts," Vol. 89, Nos. 4579 and 4581.

"Journal of Agricultural Research," Vol. 61, Nos. 9–11.

"Agricultural Gazette of New South Wales," Vol. 52, Part 3.

"Contributions from Boyce Thompson Institute," Vol. 11, No. 6.

"The Journal of Chemical Physics," Vol. 9, No. 3.

"Journal of the Indian Chemical Society," Vol. 18, No. 1.

"Experiment Station Record," Vol. 84, Nos. 2–3.

"Indian Forester," Vol. 67, No. 5.

"Transactions of the Faraday Society," Vol. 37, Parts 1 and 2.

"Indian Farming," Vol. 2, No. 4.

"Geological, Mining and Metallurgical Society of India" (Journal), Vol. 12, No. 3.

"The Hyderabad Academy Studies," No. 2 (1940).

"Indian Central Jute Committee" (Bulletin), Vol. 4, No. 1.

"Bulletin of the American Meteorological Society," Vol. 22, No. 1.

"The Indian Medical Gazette," Vol. 76, No. 4.

"Journal of Nutrition," Vol. 21, No. 3.

"American Museum of Natural History," Vol. 47, No. 3.

"Nature," Vol. 147, Nos. 3716–18, 3720, 3721 and 3724.

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"Sky," Vol. 5, No. 6.

"Science and Culture," Vol. 6, No. 11.

"Sankhya," Vol. 5, No. 2.

"Indian Trade Journal," Vol. 140, Nos. 1816–20.

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"The Chemical Action of Ultra-Violet Rays," by Carleton Ellis and Alfred A. Wells. (Reinhold Publishing Co., N.Y.), 1941. Pp. 961. Price $12·00.

"Handbook of Economic Entomology for South India," by T. V. Ramakrishna Iyer. (Government Press, Madras), 1940. Pp. xviii + 528. Price Rs. 4–12.

"Canning Practice and Control," by Osman Jones and T. W. Jones. (Chapman & Hall, Ltd., London), 1941. Pp. xiv + 300. Price 32*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

April 1941, SECTION A.—H. J. BHABHA: *Note on the correspondence between the classical and quantum theories of neutral mesons.* K. RANGANATHA RAO AND T. R. SESHADRI: *Synthesis of 7-hydroxy-5-methylcoumarin.* R. VENKATARAMAN: *The kinetics of the olefin-bromine reaction. Part III. A note on the influence of different catalysts on the reaction.* P. BHASKARA RAMA MURTI: *A study of the chemical components of the roots of* Decalepis Hamiltonii (*Makali Veru*). *Part II. A note on the preparation of inositol by solvent extraction.* S. BHAGAVANTAM AND J. BHIMASENACHAR: *Modified reflection of X-rays: Naphthalene.* Modified X-ray reflections due to (001), (002), and (201) planes of naphthalene have been recorded only when the crystal setting is very near that of the critical setting in each case. For orientations which differ appreciably from the above settings, the intensity of the modified spots appears to be very low. R. V. BHAT: *Adaptation of the micro-Kjeldahl method to the estimation of nitrogen in organic compounds containing nitro and azo groups.* (LATE) N. W. HIRWE AND B. V. PATIL: *Studies in chloral amides. Part VII. Reactivity of the α-OH group in chloral bromo salicylamides and their methyl ethers.* (LATE) N. W. HIRWE AND J. S. DESHPANDE: *Studies in chloral amides. Part VIII. Condensation of toluic amides with chloral.* (LATE) N. W. HIRWE AND J. S. DESHPANDE: *Studies in chloral amides. Part IX. Reactivity of α-chlorine in α-chloro-chloral toluic amides.* K. G. KRISHNAN: *Dispersion of ultrasonic velocity in organic liquids.* With seventeen organic liquids over the range 3500 kc to 8000 kc no

dispersion has been recorded. P. G. N. NAYAR: *Temperature variation of the Raman frequency of diamond.* Over the range of temperature −190° C. to 860° C. the characteristic Raman line varies from 1333·8 cm.$^{-1}$ to 1316 cm.$^{-1}$ From the thermodynamical relation between the thermal expansion of the crystal and the variation of the characteristic frequency, it has been found that the change observed is greater than that expressed. R. NORRIS: *The Raman spectrum and the specific heat of crystalline sulphur.* D. NARAYANAMURTI AND V. RANGANATHAN: *The thermal conductivity of Indian timbers. Part I. Variation of conductivity with density in the air-dry condition at ordinary temperature.* S. RNGASWAMI, T. R. SESHADRI AND V. VENKATESWARLU: *The remarkable fluorescence of certain coumarin derivatives.*

SECTION B.—T. S. RAGHAVAN AND V. K. SRINIVASAN: *Morphological and cytological studies in the scrophulariaceæ. Part IV. The development of the embryo-sac and endosperm in* Scoparia dulcis *Linn.* T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the capparidaceæ. VIII. The floral morphology of* Crataeva religiosa *Forst.* B. R. SESHACHAR: *The interstitial cells in the testis of* Ichthyophis glutinosus *Linn.* H. CHAUDHURI AND A. R. QURAISHI: *A study of the fungal endophyte of some* Anthoceros erectus *Kashyap.* M. SRINIVASAN, S. RAMASWAMY AND M. SREENIVASAYA: *A rapid method of determining peroxidase activity.*

Indian Association for the Cultivation of Science: (*Proceedings*)

December 1940.—G. N. BHATTACHARYA: *Specific heat of lac.* K. R. RAO AND M. G. SASTRY: *The first-spark spectrum of tellurium.* M. G. SASTRY: *Interferometric measurements of certain lines in the spectrum of bromine.* S. D. CHATTERJEE: *Study of thermal neutrons in the atmosphere.* L. D. MAHAJAN: *Adsorption of moisture from the moist air by the soils.* A. C. DEB: *Penetration of thin ionospheric layers.* B. N. SINGH: *Joule-Thomson and Joule effects for Bose-Einstein and Fermi-Diric gas.* M. GHOSH: *Dynamics of the pianoforte string and the hammer. Part IV (Study of duration of impact).* M. GHOSH: *Dynamics of the pianoforte string and the hammer. Part V (Some special theories).*

Meteorological Office Colloquium, Poona:

March 11, 1941.—B. N. DESAI: *Variation of lapse rate of temperature near the ground at Drigh Road, Karachi.*

March 18, 1941.—K. R. RAMANATHAN: *Atmospheric visibility.*

March 25, 1941.—P. R. CHIDAMBARA IYER: *Sunspots and prominences.*

Botanical Society of Bengal:

March 26, 1941.—G. P. MAJUMDAR: *On the origin of medullation in Selaginella.* A. K. GHOSH: *On the theoretical significance of bisporangiate sporophyll in* Lycopodium phlegmaria *Linn.*

Tin and Its Uses

The latest issue of the Tin Research Institute's Quarterly Review (No. 8) gives details of some improved pewter alloys containing over 90 per cent. of tin, which have all the merits of malleability and attractive sheen associated with the usual pewter alloys, but are substantially stronger. Spinning and other fabricating operations are as easily carried out as with ordinary pewter, but when finished articles of the new pewter are given a simple heat treatment; they develop 70 to 80 per cent. greater strength, and this strength is permanently retained in service conditions.

An announcement is made of the Institute's new booklet on Hot-Tinning (Publication 102), which describes the process as applied to cast iron, steels and alloy steels, copper and copper alloys, and shows how to overcome the difficulties which may arise.

An article on electro-tinning contrasts the old-fashioned stannous chloride bath with modern plating baths; it is shown that the former bath is of value only for producing very thin tin coatings of bright appearance, but modern baths will give tin coatings of any thickness desired, and so are of particular value for food processing equipment.

An article on opacifiers for vitreous enamels indicates that the special qualities of tin oxide have enabled it to maintain its position in the enamelling industry.

An example of the value of tin as a protective coating on steel is provided by its use in connection with the nitriding process, in which surfaces to be kept in an unhardened state are protected by a layer of tin. Nitriding is applied to cylinders, crankshafts, gears, shacklepins and valve sleeves for aero, automobile and Diesel engines as well as to textile, cement and plastic-moulding machinery.

Among the examples of the Institute's free Technical Service are particulars of a simple but sensitive chemical test for identifying tin in white-metal scrap, and of special tin solders which have higher melting points and greater strength than the usual tin-lead alloys.

ERRATA

Vol. 10, *No.* 4, *April* 1941:—

Contribution entitled "Cinchona Cultivation in India", page 223, para 2, line 8, *for* "21,00 lbs." *read* "210,000 lbs.".

Note entitled "Modified Equations for Adsorption and Base-Exchange in Soils", page 203, Table II, column 4, *for* $x = \frac{BU}{I+C'}$ *read* $x = \frac{BI}{I+C'}$;

Table II, column 5, the last but one value *for* 1·123 *read* 1·213.

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POST-WAR INDUSTRIAL RECONSTRUCTION

THE Government of India, in a communique dated 6th June 1941, have announced their decision to appoint a committee to consider post-war problems of Industrial reconstruction. This is a decision which will be warmly welcomed by every one interested in the industrial advancement of this country.

Since the commencement of the present war, there has been an ever-increasing amount of agitation from several responsible quarters, urging the Central Government to adopt a bold, vigorous, forward and enlightened policy for ensuring a carefully planned and enduring industrialisation of the country. For a second time in her industrial history, India has realised her helpless dependence on foreign imports for many of her essential needs and there has been an insistent demand on the part of the public and the press, that this opportunity should not be lost for mobilising the vast material resources and the potential scientific and technical talent for the industrial regeneration of the country.

At a recent meeting of the Industries Conference (December 1940) the Hon'ble Sir A. Ramaswami Mudaliar stated that the Government of India could give the commercial community an indication of the kind of industries which may safely be developed during the war and of the nature of assistance they could extend to such industries. This statement is re-assuring. There has been, however, a justifiable feeling that while the Government owing to stress of war, are concentrating their attention on war industries, other industries, which are essential for consolidating the industrial position of India have been either neglected or ignored. Taking into account the vast resources of the country, the urgency for rapid industrialisation and the exceptional opportunity offered by the war, the efforts of the Government, fall far short of public expectation. Addressing the All-India Manufacturers' Conference in Bombay (March 1, 1941) Sir M. Visvesvaraya, declared: "We must impress on the Government that they will not have discharged their duty to the

people of this country by encouraging only war industries which can be in production by the middle of 1942, but, that an endeavour is expected in this emergency on their part to make the country self-contained in as many requirements, both for peace and war, as posible." He pointed out that through lack of organisation, the country had practically stood still and allowed itself to be outstripped by many a foreign country within the last fifty years. "Our resources in men and material, if wisely utilised are colossal. A plan, leadership and an economic drive are the essential needs of the industrial situation to-day and these are lacking." Mr. Shah, Chairman of the Reception Committee of the same Conference, in the course of his welcome address, said that "the best use of the opportunity afforded by the war was not made, except in regard to the manufacture of munitions and other war materials under Government ægis. The fundamental objective of making a rapid stride in the pace of industrialisation was not being attended to with the vigour, enthusiasm and persistence, which the occasion demands." A similar view was expressed by Mr. G. L. Mehta, Vice-President of the Federation of Indian Chambers of Commerce and Industry, when he pointed out at a recent meeting of the Institution of Chemists (India) that the "authorities responsible for shaping the economic policies of our Government have been under the influence and domination of those interested in keeping their hold over the Indian market with the consequence, that the vital economic interests of India have been subordinated to those of the manufacturers and exporters in the United Kingdom". It will be superfluous to enumerate here the lacunæ in the industrial organisation of this country. The present offers a rare opportunity for filling them up. To take one instance, the establishment of heavy engineering and machine industries as a step for the manufacture of automobiles and the building of ships is urgently called for. The Government should take active steps for helping the establishment of these industries as a long-range proposition. The post-war period which followed the termination of the Great War, did not witness the materialisation of the great hopes which were raised at the time; on the other hand, the country's markets were flooded with foreign manufactures and the indigenous industrial effort was swamped out of existence. If the Government of India at the time, had only utilised the opportunity of making this country industrially strong and prosperous, the Empire, in its present crisis, would have had in India, a willing and mighty partner contributing substantially towards the war effort.

The Government of India have constituted the Board of Scientific and Industrial Research under the inspiring direction of Sir S. S. Bhatnagar; the Industrial Utilisation Committee has been brought into being as the logical sequence of the fruitful labours of the Board; several important lines of industrial research have been inaugurated; the resources of practically every laboratory in the country, have been utilised for the promotion of technical research. Indeed for the first time, there has been a belated, but nevertheless an earnest attempt on the part of the Government to recognise scientific research as a factor indispensable to the industrial economy of the nation.

During the short interval of less than a year and with the limited and meagre resources made available, the scientific workers in the country, have already justified the trust placed in them. The country

has provided ample demonstration, if any demonstration were needed, that industries can be successfully started in this country provided foreign competition is kept in check. At the moment the country is favoured with a condition of dwindling imports as a result of the European conflict. This is a condition which can be maintained even after the return of peace by the imposition of tariffs and legislating other forms of protection. These are well recognised and widely practised measures which are adopted by enlightened governments to effectively safeguard a peaceful and ordered development of their national industries.

The public and the industrialists of the country have a heavy responsibility in planning the industrial effort during the impending post-war period. Industrialists should collaborate with the scientific workers and finance researches which have a bearing on their industries. The financial support given by the Government of India is entirely inadequate considering the vastness of the field of research which confronts the country. The Government of India should increase its grant for industrial research and foresighted manufacturers should play their part in contributing towards research not only as a part of their long-term investment but as a social obligation. Mr. G. L. Mehta, in the course of his address referred to above, made the practical suggestion that a substantial portion of the revenues made available from the Excess Profits Tax might be usefully employed for the promotion of industrial research. Research Associations for specific industries composed of manufacturers' representatives and the research workers in the field should be started. This will pave the way for a closer and more fruitful contact between the scientists and industrialists and both will grow more and more appreciative of each other's point of view.

The Government of India have appointed the Post-war Industrial Reconstruction Committee, which is expected to consider problems of reconstruction in all its bearings. Industries that are now being developed as rapidly and extensively as possible, will no longer be actively engaged upon urgent war contracts; labour, now busy with these industries, will become redundant; there will be a surplus of stocks. In addition to these, the country will have to face keen competition from the industrially advanced nations whose productive efficiency, now harnessed for war industries, will be diverted towards peace-time manufactures. These problems will no doubt receive the careful and earnest attention of the Committee on which financial interests are adequately represented. The inclusion of the Director of Scientific and Industrial Research and the Director of the Indian Institute of Science, both of whom are actively engaged in directing Industrial research, will substantially facilitate the work of the Committee.

In the generous and wise words of Sir Fredirick Nicholson, the Government is "bound to consider Indian interests firstly, secondly and thirdly—I mean by 'firstly' that the local raw materials should be utilised, by 'secondly', that industries should be introduced, and by 'thirdly', that profits of such industries should remain in the country". To quote Pandit Malaviaji: "If measures for the industrial development of India are taken in this spirit, India will become prosperous and strong and England more prosperous and stronger."

CHROMOSOME NUMBER AND POLYPLOIDY IN AMPHIBIA

BY

B. R. SESHACHAR, D.Sc.

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A VERY large amount of recent work has brought to light many important features in the chromosome cytology of Amphibia. Many of the early studies were confined to the chromosomes of the common Anura and Urodela and it is only recently that an extension of these studies has been made with reference to the other amphibians. Up till 1937 (Oguma and Makino) the chromosome numbers of one species of Apoda, 37 of Urodela and 30 of Anura were known. The chromosome number of one other species of Apoda has since been added (Seshachar, 1939).

From a study of the chromosome number in Amphibia it becomes clear that the variation in the chromosome number within the group obeys fixed laws. In Apoda, the number in only two species is known: $n = 21$ in *Ichthyophis glutinosus* and $n = 18$ in *Uræotyphlus narayani* (Seshachar, 1937; 1939). Among the Urodela the lowest number recorded is in *Proteus anguineus* (Stieve, 1920) where $n = 9$. In the majority of the Urodela belonging to the Amphiumidæ and Salamandridæ, the basal chromosome number shows an astonishing uniformity and might be taken to be the typical urodelan number. It is $n = 12$. In the Cryptobranchidæ and Hynobiidæ, however, there is a distinct departure. This variation is all the more striking because the difference between the basal urodelan number and that in the known examples of the above two families is very great. In fact, the latter is often more than twice the former. The numbers are as follows: $n = 20$ in *Hynobius retardatus* and varies from $n = 28$ in the majority of the species of *Hynobius* (*H. leechii, H. nigrescens, H. nebulosus, H. dunni*) to $n = 31$ in *Salamandrella keyserlingii*. In *Cryptobranchus allegheniensis* it is 31 and $n = 32$ in *Megalobatrachus japonicus*.

The variation is not so striking in Anura. *Bufo* appears to have $n = 11$ and in *Rana* n is generally 12. Many other species disclose this latter number (species of *Bombinator, Hyla*). The highest number observed in Anura is in *Alytes obstetricans* where $n = 16$ (Janssens & Willems, 1909).

From the foregoing account of the chromosome number in Amphibia certain conclusions can be drawn. The basal number in Amphibia appears to be $n = 12$. Wherever there are variations, in the majority of cases these variations may be traced to a fragmentation of the chromosomes resulting in a multiplication in the number. The work of the author has shown that the apparently diverse chromosome numbers in the two species of Apoda whose numbers are known, is deducible, according to Robertson's law, to the same basal number, which in this case is $n = 13$.

But the very large number of chromosomes found in examples of Cryptobranchidæ and Hynobiidæ cannot apparently be explained by Robertson's law and must have been brought about by a totally different kind of fragmentation from that which has resulted in the slight variations found in some species of Urodela, Anura and Apoda. The presence of a very large number of V-shaped chromosomes with atelomitic attachments precludes the application of this law. And apart from the fact that in these two families the basal number appears uniformly to be $n = 28$, nothing more can be said either about the origin or the significance of this change from the typical amphibian basal number of $n = 12$.

Vandel (1938) has, after a critical examination of the number of chromosomes in vertebrates, come to the conclusion that while in many vertebrates the basal number is $n = 12$, any increase (which is probably due to fragmentation) indicates a specialization and is correlated with the evolution of the group. He does not account for the enormous number of chromosomes found in Cryptobranchidæ and Hynobiidæ. While it is possible that these two families form exceptions to the rule, the origin of their chromosome numbers still remains to be

determined. And while fragmentation in general might indicate an evolutionary specialization within the group, the fragmentation in the case of these two families (if it is fragmentation) must have a totally different significance.

In this respect Anura is a more stable group. None of the species whose chromosomes are known exhibits the huge variations seen in Urodela and the slight changes in number noticed here have probably been brought about by fragmentation and indicate specialization. As already observed, the chromosomes of only two species of Apoda have been known and it is desirable that our knowledge of this group is wider before any definite conclusions are drawn. But it is significant that these two species, when Robertson's law is applied, reveal a basal number, $n = 13$.

Polyploidy.—Generally in animals, polyploidy is rare and whenever it occurs, it has not the same significance as in plants. Among Amphibia, triploids have been reported in *Rana esculenta* (Hertwig & Hertwig, 1920) and in the urodeles, *Triton palmatus* (Fankhauser, 1934) and *T. viridescens* (Fankhauser & Kaylor, 1935). Parthenogenetic triploid larvæ have been reported in *Rana pipiens* (Parmenter, 1933) and in *Rana nigromaculata* (Kawamura, 1939). Triploid and tetraploid larvæ have been found in *Eurycea bislineata* (Fankhauser, 1939).

Experimentally it is possible to induce polyploidy and of all the methods the most productive so far as the Amphibia are concerned, is the temperature factor; and Fankhauser and his colleagues have thrown much light on this problem in the urodeles.

It is a well-known fact that low temperatures applied during meiosis in plants result in a non-reduction of the chromosomes in the gametes which therefore retain the diploid number (Belling, 1925). The fusion of such diploid gametes with normal haploid gametes produces triploid zygotes. While low temperatures produce gametic duplication of the chromosomes, high temperatures produce somatic doubling.

Rostand (1936) first applied these methods to frogs and toads and was at once successful. In his hybridization experiments between frogs and toads, he exposed eggs immediately after insemination (with sperms of a different genus) to refrigeration and produced normal diploid gynogenetic tadpoles from these eggs. But it was found on cytological examination that the male chromosomes had not fused with those of the female and therefore the diploid nature was due to quite a different cause. It was discovered that the haploid chromosomes of the female had become doubled due to refrigeration. It probably had happened this way: in many Amphibia the nucleus of the egg is in the metaphase (Frog) or anaphase (Urodele) of the second division at the time of insemination and so, refrigeration immediately after, prevented the completion of this division. The result was, that the chromosomes of mitosis which should have gone into the second polar body came to be retained in the egg, which therefore became diploid. On the same analogy it is found that in newts (*Triturus*), triploid larvæ can be obtained only by refrigerating the eggs immediately after they are laid. Even if refrigeration is delayed by half an hour, normal diploid larvæ result. The explanation is that when the egg is laid, the nucleus is in the second division of meiosis, which is completed in about an hour's time after laying. An inhibition of this division which is the only method of making the egg diploid, can take place by refrigeration if applied quite soon after the eggs are laid (Griffiths, 1941).

Polyploidy in animals always leads to abnormalities and to death. In the urodeles studied, the animals lived up to metamorphosis and in no instance could complete it.

It is a well-known fact that among plants and also in many animals polyploidy leads to gigantism. In animals, Vandel (1927) reports it in the isopod, *Trichoniscus*, Seiler (1927) in *Solenobia* and Artom (1928) in *Artemia*. But in Urodela, no gigantism, either in triploid or pentaploid *Triturus* or in tetraploid *Eurycea* is seen. The gigantism in polyploid plants and animals is generally due to the fact that while the cell number in organs remains the same, the cell size becomes very much larger. In polyploid newts on the other hand, the cell size is larger, but the cell number in each organ is reduced with the result that the size of the

polyploid animal remains almost the same as that of the diploid one. Similar instances of polyploid plants, where in spite of larger size of the cells, the plant size on the whole remains normal is reported by Hagerup (1932) in *Euphorbia granulata*. Fankhauser (1941) recently found a single pentaploid *Triturus viridescens* whose body size was not different from that of the normal diploid individual of the same age, though the cell size was very much larger than the normal. This points to the conclusion that in newts there is some regulatory mechanism which comes into play in polyploid individuals and which reduces the cell number in the organs to offset the increase in cell size.

The cytology of the effect of abnormal temperatures in producing polyploidy can only be conjectured at this stage. It is clear that of the two structures of the cell in meiosis,—the chromosomes and the spindle, —temperature has its effect only on the spindle and not on the chromosomes, for the latter are seen to behave normally and to divide, but their separation into two distinct daughter nuclei is prevented. This is probably due to some disturbances in the spindle mechanism brought about by change of temperature.

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CANCER RESEARCH IN INDIA

THE TATA MEMORIAL HOSPITAL which His Excellency Sir Roger Lumley, Governor of Bombay, opened on 30th April 1941, is one of the benefactions which India owes to the illustrious Tata family. This splendidly equipped institution dedicated to the treatment of Cancer will serve not only the purpose of a hospital, but also that of an advanced centre of research for the study of this malignant disease.

In a special supplement to the *Times of India*, dated 1st March 1941, Dr. V. R. Khanolkar, Director of the Cancer Research Laboratory, writes: "The establishment of a hospital devoted to cancer research in Bombay on the lines of the Memorial Hospital in New York, is a departure which takes into account the shortcomings of purely experimental institutions in other parts of the world. Just now when a large part of the world is involved in a life and death struggle and the best energies of the human race are directed towards destructive activities, it is an important achievement to have started a humanitarian institution for the better care of people suffering from malignant diseases.

"The Tata Memorial Hospital is particularly fortunate, inasmuch as the Trustees have been farsighted enough to organise a place where besides study, treatment and laboratory research would be intimately coordinated and the clinician will be a research worker, and a laboratory investigator will have an opportunity of extending the experience gained from the laboratory to the hospital patient.

"The institution is unique in its conception inasmuch as most of the clinicians and the whole of the laboratory staff will be devoting their whole time to the work at the institution."

ON THE HEAT-WAVE OVER NORTHERN INDIA IN APRIL-MAY, 1941

BY

C. RAMASWAMI, M.A.

(*Meteorological Office, Poona*)

THE outstanding feature of Indian weather in the second half of April and the first week of May of this year was the extremely high temperatures over a large part of Northern India. For nearly a fortnight during this period, the temperatures were generally 8° to 15° F. above normal in the North-West Frontier Province and the whole of the Punjab, while in the west United Provinces, east Central India, the northeast Central Provinces and the adjoining districts of the east United Provinces they were 6° to 10° F. above normal continuously for more than three weeks. On account of the heat-wave, a number of deaths due to sun-stroke are reported to have occurred in the Punjab and the United Provinces.

High temperatures were first recorded in the region extending from the Punjab to the northeast Central Provinces on the 8th April in the front of a western disturbance. With the eastward movement of the disturbance, the temperatures decreased slightly, but still remained above normal in the west United Provinces, east Central India and the northeast Central Provinces. Thereafter, the temperatures gradually rose in the North-West Frontier Province also and became above normal on the 13th. The high temperatures then extended eastwards and southwards into the Punjab, upper Sind, the United Provinces and Central India. The heat-wave was at its maximum on the 4th May when most of the stations in the Punjab and a number of stations in the United Provinces recorded 115° F. and above. The spell of high temperatures continued till the 7th or 8th and was finally broken by two active western disturbances which took a fairly southerly course and produced extensive dust and thunderstorms in the Punjab and the United Provinces between the 9th and 13th.

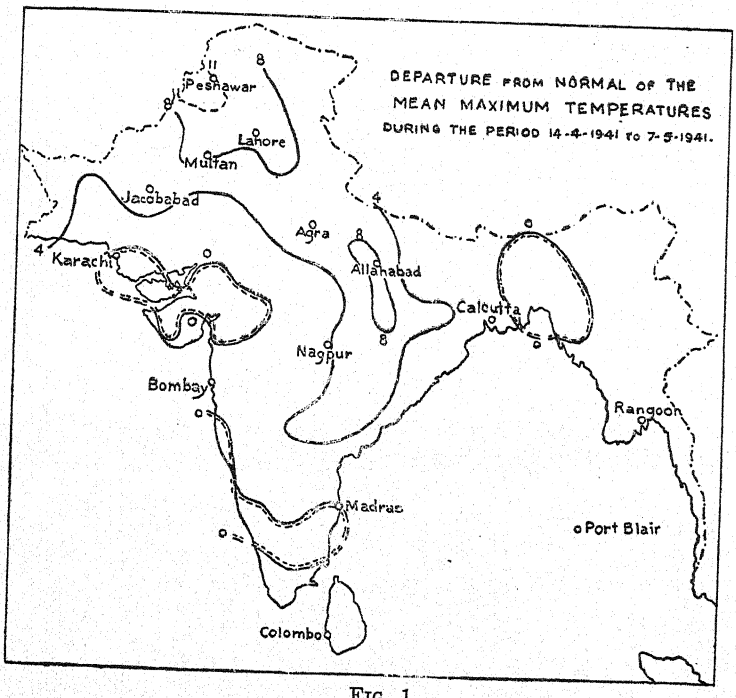

FIG. 1

The departures from normal of the mean maximum temperatures during the period 14th April to the 7th May and of the actual maximum temperatures on the 4th May are shown in Figs. 1 and 2 respectively.

The following table gives the highest temperatures recorded this year in April and those ever recorded in the same month in previous years. It will be seen that the maximum temperatures this year in April broke all previous records for the month in the North-West Frontier Province, while, in the southwest Punjab, they touched the highest temperatures so far recorded.

It is interesting to note that the high temperatures produced a "heat low" over the Punjab with a pressure

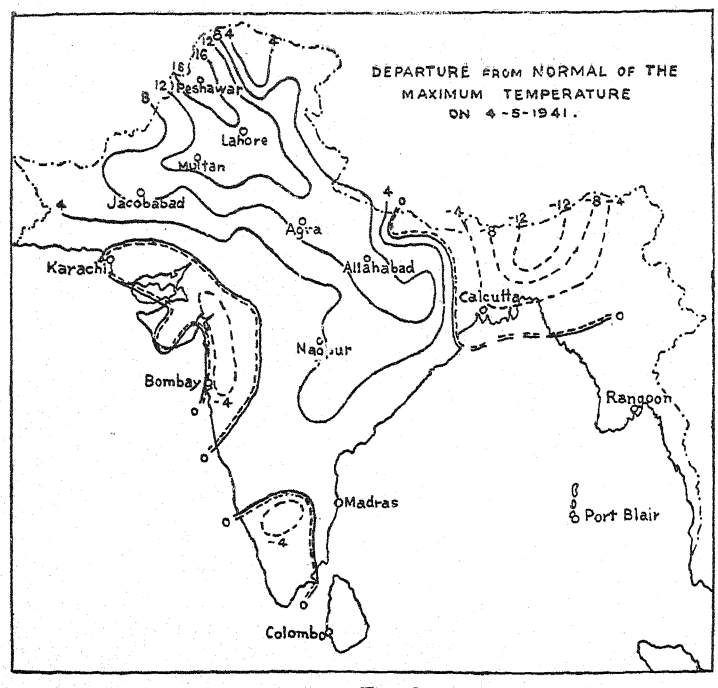

FIG. 2

TABLE I

Province	Highest temperature recorded in April this year	Highest temperature ever recorded in April in the past
North-West Frontier Province	116° F. at Dera Ismail Khan on the 28th	113° F. at Dera Ismail Khan on the 18th April 1892
Punjab Southwest	116° F. at Leiah and Multan on the 27th and 28th and at Khushab on the 28th	116° F. at Khushab on the 22nd April 1892
Punjab, East and North	115° F. at Ludhiana on the 27th and 28th and at Lahore on the 28th	117° F. at Sirsa on the 18th April 1892
United Provinces, West	113° F. at Agra on the 27th and 28th	114° F. at Jhansi on the 28th April 1914.
United Provinces, East	113° F. at Cawnpore on the 27th	114° F. at Allahabad on the 28th April 1879

deficiency of nearly one-third of an inch of mercury, when the heat-wave was at its peak. Had such a defect in pressure been associated with a western disturbance, there might have been a deluge in the Punjab!

Another noteworthy feature in the history of this heat-wave was that although, as many as seven westen disturbances affected the country from the middle of April to the end of the first week of May, none of them produced appreciable precipitation in the North-West Frontier Province, the Punjab and the United Provinces. All of them were feeble and took a more northerly course than usual. Thus the above Provinces were deprived of the cooling caused by dust or thunderstorm or by the movement of the cold fronts of western disturbances. This would account for the persistence of the high temperatures for such a long period.

It is generally recognised by medical men that the discomfort to the human body during heat-waves depends considerably upon the wet bulb temperature of the air: the higher the wet bulb temperature, the greater the discomfort. A temperature of 80° F. is taken to indicate the danger point for the occurrence of heat strokes. According to Dr. Haldane, "if the wet bulb temperature exceeds 78° F., continuous hard work becomes impracticable and beyond 88° F., it becomes impracticable for ordinary persons even to stay for long periods in such air". An examination of the wet bulb temperatures recorded at the various stations in northwest India during the heat-wave under discussion shows that during the period 29th April to the 5th May, the wet bulb readings at 8 hours at many of the stations in the United Provinces and the Punjab exceeded 75° F., while at some stations they touched 80° F. and above. The temperatures must have been still higher at the time of the maximum in the afternoon. Some of the noteworthy wet bulb readings actually recorded at 8 hours during the heat-wave were Lucknow 81° on the 2nd May, Hissar 84° on the 3rd, Fort Abbas 80° on the 2nd and 85° on the 3rd, Multan 81° on the 4th and 5th and Jacobabad 86° on the 2nd. These high temperatures must have contributed in no small measure to the sunstrokes reported during the heat-wave.

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FUSE SPECTRUM OF ALUMINIUM

Previous investigators[1] on the fuse spectra of elements have studied the reversals, the shifts and the intensities in the spectral lines emitted by wires which are exploded either by a high voltage supply or by discharge of a charged condenser through them. With a view of comparing the relative intensities of lines in the direct current fuse spectrum and in the low current arc spectrum, a study of the spectra of silver, copper and aluminium was undertaken. In the fuse spectrum of aluminium obtained in air, however, a continuous spectrum has been observed in the background and the sharp series lines are all found reversed against it. Vaudet and Servant,[2] who exploded aluminium wire in vacuum by discharge of a 0·64μF condenser charged to 50 Kv., report the entire absence of a continuous background. In the present investigation, the wire was exploded by joining it directly across a 120 volt D.C. supply. Fig. 1 (A) is a reproduction of the spectrum in the region λ2300–2100 Å, and the continuous spectrum is observed to extend beyond 2100 Å; the accompanying low current arc spectrum (B) reveals the absence of any continuous spectrum. The emission of the continuum in the fuse spectrum of aluminium has given rise to the appearance of the sharp series lines

$$3\,^2P_{\frac{1}{2},\frac{3}{2}} - n\,^2S_{\frac{1}{2}}$$

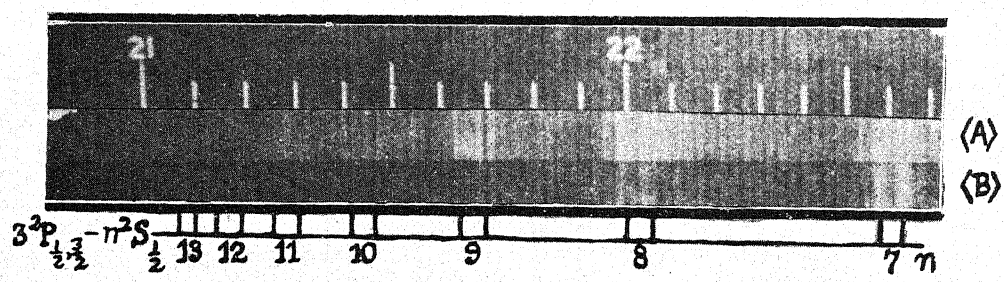

Fig. 1

in absorption. Those who have studied the arc spectrum of aluminium earlier have observed these lines only upto $n = 8$, as the arc spectrum reproduced in Fig. 1 (B) indicates. When the aluminium wire explodes due to a passage of current of the order of 60 amps., instantaneously an atmosphere of aluminium vapour surrounds the discharge. As a consequence the emission lines of the sharp series are all reversed by absorption in aluminium vapour. Even in the fuse spectrum a closer examination reveals that only the lines upto $n = 8$ or 9 are emitted and then reversed; but higher members of this series extending upto $n = 14$ are seen reversed against the continuum. As in the arc spectrum, the higher members are probably not radiated, but the aluminium vapour exercises a selective absorption on the continuous spectrum. The strengthening of the continuum in this region may partly arise from the widening out of the lines of the diffuse series.

In conclusion I desire to thank Dr. L. Sibaiya for his kind guidance.

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Central College,
Bangalore,
May 12, 1941.

[1] Anderson, *Astrophys. Jour.*, 1920, **51,** 37; Anderson and Smith, *Ibid.*, 1926, **64,** 295; Menzies, *Proc. Roy. Soc.*, 1928, **117,** 88; Futagami, *Inst. Chem. Research, Tokyo, Sci. Papers*, 1937, **671,** 1.

[2] Vaudet and Servant, *Comptes Rendus*, 1935, **201,** 195.

ON THE STABILITY OF VITAMINISED OIL

IN the second Addendum to *British Pharmacopœia,* 1932, it has been suggested that a vitamin A and D concentrate may be dissolved in a suitable vegetable oil to obtain the *Oleum vitaminatum,* B.P. But as vegetable oils gradually develop rancidity through the formation of peroxides which are found to be responsible for the destruction of Vitamin A in Cod and Halibut liver oils,[1] it was considered to be of interest to have a knowledge on the vitamin A destruction in the type of a vitaminised oil as suggested in the B.P. Addendum.

Accordingly, an investigation has been undertaken to compare the oxidative changes and subsequent fall of vitamin A potency when stored under customary conditions. With a view to ascertain the relative keeping properties, dried and carbon dioxide-free air was passed for more than 96 hours at the room temperature (28° C.) through cod liver oil containing about 800 I.U. of vitamin A per gm., and through an oleum vitaminatum B.P. made from arachis as well as olive oil. The vitamin A content was determined by the well-known Car-Price method, using a Lovibond tintometer.[2] The peroxide values were determined by the method, first suggested by Nakamura[3] and subsequently modified by Basu and Mazumdar.[4] The graph (Fig. 1) shows the relative stability

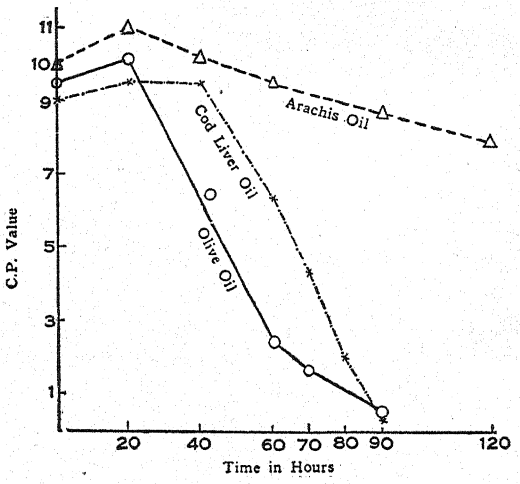

FIG. 1

of vitamin A in the three products studied so far. More than half the vitamin A potency is being retained in the vitaminised oil made with arachis oil even when air was passed through more than 160 hours; whereas almost complete destruction took place in cod liver oil within 90 hours.

To show further that the stability of vitamin A in arachis oil may be further increased by the addition of suitable anti-oxidants, the

vitaminised oil prepared with arachis oil was mixed with hydroquinine (0·2 per cent.)[5] and the oil aerated. The figures in Table I tend to indicate that though there is a slight fall of potency (10 per cent.) during the first period of 120 hours, the vitamin A value was found to remain practically constant when aeration is continued for the next 300 hours.

TABLE I

Stability of vitaminised arachis oil incorporated with 0·2% hydroquinone

Air passed for hours	Blue value	Peroxide value
0	10	0·8
60	9·4	1·0
120	9·0	1·15
180	9·0	1·5
300	8·95	1·55

Work is also in progress to show how far the oxidative changes, *i.e.*, the formations of peroxides, aldehydes and free acids in various oils are responsible for the destruction of vitamin A in such type of oleum vitaminatum B.P. and whether the destruction of vitamin A is solely dependent on the formation of peroxides in the fats.[6]

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Bengal Immunity Research
Laboratory,
Baranagore, Calcutta,
March 25, 1941.

[1] Whipple, *Oil and Soap*, 1936, **13**, 231.
Lowen *et al.*, *Ind. Eng. Chem.*, 1937, **29**, 151.
[2] Coward *et al.*, *Biochem. Jour.*, 1931, **25**, 1102.
— —, *Ibid.*, 1932, **26**, 1593.
[3] Nakamura, *Jour. Soc. Chem. Ind. Japan*, 1937, **40**, 206 B.
[4] Basu and Mazumdar, *Leprosy in India*, 1939, **2**, 54.
[5] Jones and Christiansen, *Jour. Amer. Pharm. Assoc.*, 1935, **24**, 465.
[6] Smith, *Biochem. Jour.*, 1939, **33**, 201.

CATALASE ACTIVITY IN *MANGIFERA INDICA*

THE natural drift of such enzymes as catalase, oxidase and peroxidase in the life of the fruit from fruit-setting to ripening in case of *Mangifera indica* clearly showed a close correlation with the distinct metabolic phases of the fruit.[1] The catalase activity was shown in distinct well-marked phases, *viz.*, (1) an early phase of very low activity, (2) a phase of rapid and steady increase, (3) a period of higher level activity with (4) steep rise to maximum activity, and (5) rapid decline to a minimum.

It will be seen from the table that the maximum catalase and peroxidase activities, corresponded with the mature stage of the fruit and the consequent climacteric and the higher respiratory efficiency of the fruit.

A positive correlation of the catalase and peroxidase activity of the fruit with hæmin Fe content of the tissue at that stage, can also be observed from the table.

TABLE I

Age in days from fruit-setting	Average fresh weight in gm.	Catalase mg. O_2/per gm. pulp	Peroxidase mg. glucose oxidised per gm. pulp	Hæmin Fe mg. per gm. pulp	Vitamin C mg. per gm. pulp
13	1	0·12	0·07	·016	..
42	5	0·15	0·08	·021	2·6
57	15	0·20	0·11	·036	..
72	60	0·88	0·12	·125	..
82	65	2·00	0·20	·149	1·7
84	99	3·75	0·25	..	..
99*	150	4·2	0·30	·158	..
106	150	13·5	0·35	·151	0·86
112	..	52·0	0·65	..	..
114	150	64·7	0·80	·272	..
115	..	78·4	0·85	·278	..

* At this stage ripening begins.

The enhanced catalase activity under artificial doses of ethylene[2,3] as compared to cold storage and storage under room conditions is recorded in Table II.

TABLE II

Showing catalase activity (mgO_2/gm. pulp) in storage and ethylene treatment on mature fruits of 99 days age

Days in storage	Cold storage 8°–12° C.	Ethylene treatment 28°–32° C.	Room condition 28°–32° C.
Initial conc.	4·1	4·1	4·1
7	4·9	15·0	8·25
14	4·8	16·2	9·50
21	4·9	11·8	9·50

Further studies are being carried out on cystin, cystein, glutathione and ascorbic acid drift in relation to flowering and alternate bearing in mangoes. Detailed results will be published elsewhere.

H. K. BANERJEE.
B. K. KAR.

Bose Research Institute,
Calcutta,
February 24, 1941.

[1] Kar, B. K., and Banerjee, H. K., *Nature*, 1939, **144**, 597.

[2] Bagster, L. S., *Chem. Abs.*, 1940, **34**, 4174.

[3] Kar, B. K., and Banerjee, H. K., *Curr. Sci.*, 1940, **9**, 321.

THE OCCURRENCE OF *DARLUCA FILUM* (BIV.) CAST. ON CEREAL RUSTS IN SOUTH INDIA

A NUMBER of fungi are known to parasitize the uredo sori of several rusts. Of these *Darluca filum* has been observed in several parts of the world and on different genera of rusts. Saccardo[1] has mentioned that it occurs in different parts of Europe, America, Ceylon and Africa. Solunskaya[2] has observed *D. filum* in the Ukraine parasitizing *Uromyces betæ* but it occurs too late in the development of the disease to cause any appreciable reduction of rust. Van Poeteren[3] noticed that the virulence of willow rust (*Melampsora* sp.) in Holland was considerably reduced by this fungus. Nicolas[4] mentions that the uredo sori of *Puccinia glumarum* are affected by this fungus in France. Canonaco[5] has reported the occurrence of the fungus on the uredo sori of Uredineæ of various Gramineæ in Eritrea. Fedorintchik[6] has made a detailed study of the fungus in the U.S.S.R. and states that it is parasitic only on the rusts, feeding on the spores and intercellular mycelium and not on the host. He has described a method of utilising the fungus for the control of rust. Artificial infections were successful on *Puccinia dispersa, P. simplex, P. graminis* and *P. coronifera*. It has also been noted on *Puccinia asparagi* in England.[7] From India the only record is by Butler[8] on uredinea of *Puccinia polygonia amphibii* on *Polygonum* sp. from Mussoorie.

During the last few years when specimens of *Sorghum vulgare, Pennisetum typhoides* and *Setaria italica* affected by *Puccinia purpurea, P. penniseti* and *Uromyces setaria-italicæ* respectively were collected for teaching purposes in the months of November–January, it was found that in many instances the uredo sori were parasitized by *Darluca filum*. Dark brown or almost black pycnidia were observed in large numbers protruding out from below the ruptured epidermis giving a black colour to the sori. In such sori the uredo spores were few and shrivelled.

The pycnidia are dark brown, ostiolate, nearly round or oval with a small neck in some cases. They measure on an average $81·3 \times 96·5\ \mu$ (Figs. 1 and 2). The spores are hyaline, two

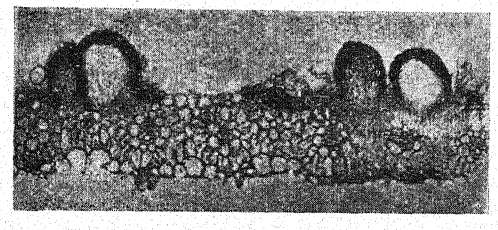

FIG. 1

Section of leaf of *Setaria italica* with *D. filum* on *Uromyces setaria italicæ* (× 200)

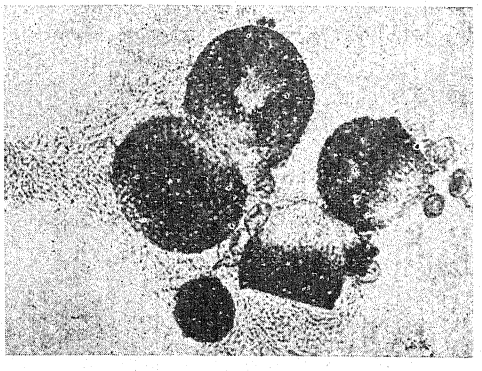

FIG. 2
Pycnidia and spores of *D. filum* (× 500)

celled with a slight constriction in the middle where the septum is present. They measure on an average $15{\cdot}4 \times 4{\cdot}1\,\mu$, the range being $12{\cdot}9 - 17{\cdot}2 \times 2{\cdot}2 - 6{\cdot}5\,\mu$.

D. filum develops usually only in the later stages of the rust infection especially during and after rainy weather. The first formed rust sori are free from infection but later in the season most of the uredo sori are affected. Though the fungus may cause damage to a large number of uredospores its usefulness in the effective control of these rusts is doubtful. As Solunskaya has stated in the case of *Uromyces betæ* the fungus comes on the scene after a lot of damage has been caused to the host plant. *D. filum* has not previously been recorded on cereal rusts in India.

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May 1, 1941.

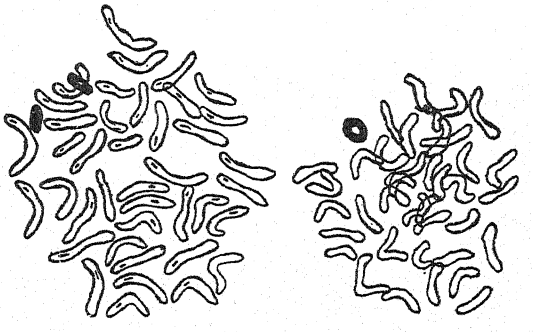
[1] *Sylloge Fungorum*, 1884, **3**, 410.
[2] *Rev. App. Myc.*, 1932, **11**, 91.
[3] *Ibid.*, 1936, **15**, 74.
[4] *Ibid.*, 1936, **15**, 488.
[5] *Ibid.*, 1937, **16**, 279.
[6] *Ibid.*, 1939, **18**, 580.
[7] *Ibid.*, 1939, **18**, 778.
[8] *Sci. Mon., I.C.A.R.*, 1931, No. 1, 154.

CERTAIN ABNORMALITIES IN THE ROOT TIP OF GROUNDNUT

IN a previous communication,[1] the occurrence of chromatin bridges in the root tip of groundnut (*Arachis*) was recorded. Certain other abnormalities noted since are given in this note.

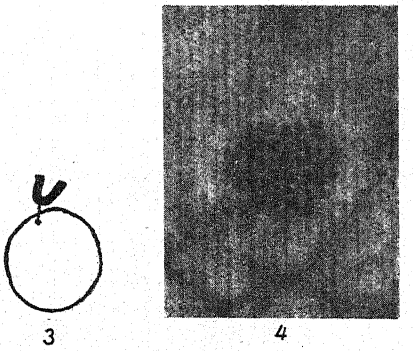
Fig. 1 shows a metaphase plate in the root tip cell of "Pollachi red", a variety of *Arachis hypogœa*. In it there are forty chromosomes and two fragments (the latter alone being shaded dark). The $2n$ number of this variety is forty. Fragmentation of chromosomes has been reported in other genera, *e.g.*, *Allium*.[2]

In Fig. 2, a metaphase plate in another variety of *Arachis hypogœa* (A.H. 73—"Native Tanganyika") is shown wherein a chromosome-ring



1 2

has been formed. Ring-chromosomes have been reported in a few genera like *Zea*,[3] *Gossypium*,[4] etc. An instance of lateral satellite was also met with in this variety at prophase (Fig. 3), which appears to have been caused by probable



3 4

inversion of the satellited chromosomes. Lateral trabants have been reported to occur as a

result of spontaneous structural changes in *Crepis*,[5] and due to X-raying in *Aloe* and *Vicia*.[6]

Another abnormality, *viz.*, somatic doubling, which has been reported in many other genera to occur either spontaneously or as a result of chemical and other treatments, was noticed in A.H. 42 ("Bunch Mozambique"), another type of *A. hypogœa*. The doubled chromosomes shown in Fig. 4 exhibit 'somatic pairing' to a striking extent due to parental homology.

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Oil Seeds Section,
Agricultural Research Institute,
Coimbatore,
May 14, 1941.

1 Babu, C. N., *Curr. Sci.*, 1941, **10**, 173.
2 Levan, A., *Hereditas*, 1932, **16**, 257.
3 McClintock, B., *Proc. Nat. Acad. Sci.*, 1932, **18**, 677.
4 Jacob, K. T., *Curr. Sci.*, 1941, **10**, 174.
5 Swezy, O., *Cytologia*, 1935, **6**, 266.
6 Camara, A., *Bull. Soc. Ital. Biol. Sperim*, 1939, **17**, 46.

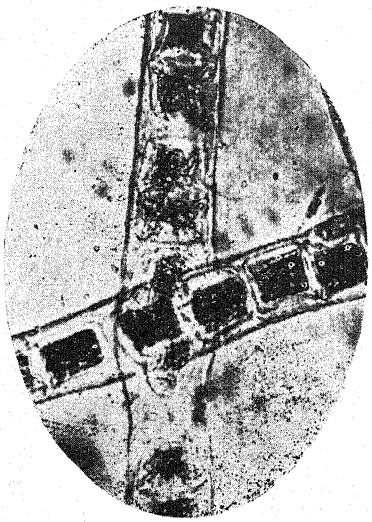
GENUS *CYLINDROCAPSA* IN INDIA

SPECIES of *Cylindrocapsa* are by no means rare in India. During the collections of algæ from the Punjab and the United Provinces from 1929 to 1941, the writer came across three species. Of these, the commonest is *C. œdogonioides*,[1] with vegetative cells 18μ to 20μ broad and 12μ to 28μ long, which was collected in a fertile condition from a tank at Dasuya in the Punjab, and in sterile condition from many 'jheels' and sluggish freshwater streams in Fyzabad and Gonda districts of Oudh in the months of January, February and March. In sterile condition this alga resembles *C. geminella* Wolle in cell dimensions. The second species with cells intermediate in size between *C. œdogonioides* and *C. scytonemoides* was collected from the surface of stones mixed with a diminutive species of *Stigeoclonium* and numerous Myxophyceæ from Kosi, a torrential stream near Almora in September, 1939. The third species is *C. scytonemoides*,[2] which has the broadest cells (24 to 30μ) among all the species. This alga also shows a peculiar mode of vegetative propagation and was collected by the present author from a freshwater drainage channel near village Mamrezpore in Fyzabad district.

A very interesting note was communicated by Iyengar[3] on the life-history of a *Cylindrocapsa* collected by him from Madras, which he provisionally described as *C. gemminella* Wolle. In a foot-note this author observes, "The Alga in its life-history differs in several aspects from *C. involuta* and also from *C. geminella*". Though dimensions of the cells and filaments of the Madras species of *Cylindrocapsa* were not given by Iyengar in the preliminary note but from his photo-micrographs, the present author saw a number of resemblances between the Madras *Cylindrocapsa* and the Fyzabad *Cylindrocapsa* which he had described as *C. scytonemoides*. Prof. Iyengar very kindly sent me a sample of his specimen which was closely examined and compared with the Fyzabad specimen. This has convinced the present author that the Madras specimen is identical with *C. scytonemoides*.

The samples collected from Fyzabad were all in a purely vegetative condition, loaded with starch particles which obscured the structure of the chloroplasts described as a massive parietal bodies as in other species of *Cylindrocapsa*. Describing the chloroplasts of his specimen, Iyengar[3] observed, "A careful examination of the living material shows very clearly that the chloroplast is definitely stellate". On careful examination of the same material by me the cells were observed in an active state of cell-division and the chloroplasts were stellate only in younger cells. In mature cells they were of the usual parietal type (Fig. 1). The stellate shape in younger cells results from the in-growth of mucilaginous lamellæ. However, the normal type of chloroplast in this alga may be safely described as *parietal and not stellate*.

Re-examination of Prof. Iyengar's material further revealed the presence of the peculiar mode of vegetative propagation described by the present author[2] from the Fyzabad material. Unlike other filamentous green algæ, species of



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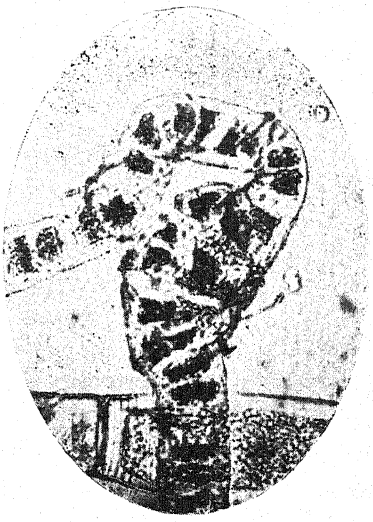

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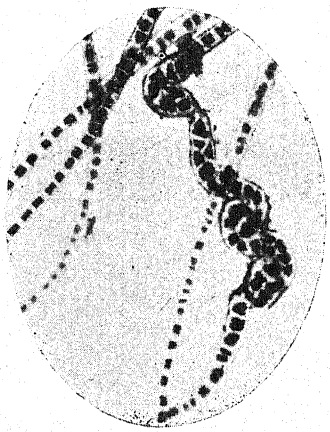

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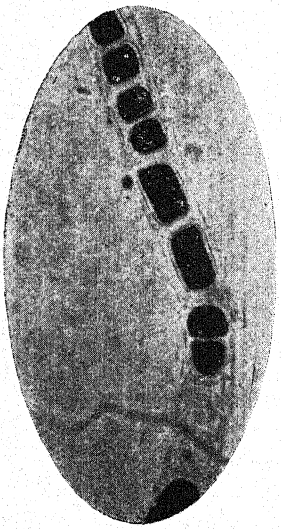

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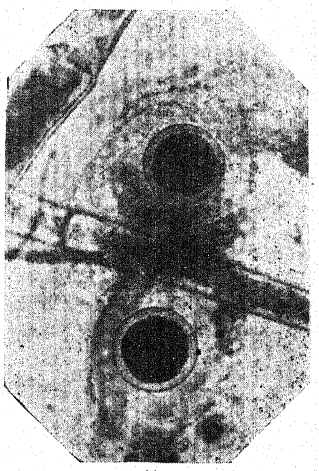

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Cylindrocapsa scytonemoides Randhawa
(Figs. 1-3)

Fig. 1.—Showing stellate and massive parietal chloroplasts in the same material.

Figs. 2 & 3.—Stages in vegetative reproduction.

Note.—Photomicrographs 1-3 of Prof. Iyengar's material from Madras.

Cylindrocapsa œdogonioides Randhawa
(Figs. 4 and 5)

Fig. 4.—A filament showing cells with chloroplasts and empty cells from which motile contents have escaped.

Fig. 5.—Showing two detached oogonia.

Cylindrocapsa are more primitive in their organisation and the individual cells retain the power of independent growth and development not only in a straight linear direction, but also laterally so that the filaments become bi-seriate at places (Fig. 2). This behaviour results in the production of hormogone-like filaments which remain glued together for some time and ultimately dissociate (Fig. 3).

In *C. œdogonioides* usually cogonia develop by the enlargement of ordinary vegetative cells, singly or in pairs as in species of *Œdogonium*. On reading Iyengar's account of the life-history of *C. geminella* Wolle (= *C. scytonemoides*), which strikes at once as very unusual and unique among algæ, the present author re-examined his material. On certain filaments of *Œdogonium*, found mixed with *C. œdogonioides*, he discovered certain *detached oogonia* also, similar to those figured by Iyengar, but with ripe thick-walled oospores (Fig. 5). Though such detached oogonia were seen before also, but their significance was missed and their detached position was thought to be due to accidental dissociation from some filaments. These detached oogonia seem to point out that in *C. œdogonioides* also quadriciliate female macro-zoospores are produced, which after a period of swarming, settle down, secrete a cell-wall which becomes the loose sheath of the oogonium, while protoplasmic contents round off and produce an oosphere. It is likely that even the oospheres in the oogonia found in the filaments have also an abbreviated, flagellate-free-swimming phase.

The life-cycle of *C. scytonemoides* as observed by Iyengar is unique among green algæ. A certain parallelism is seen between the dwarf males of *Œdogonium* and those of *C. scytonemoides*; but there is no structure in *Œdogonium* comparable with the detached oogonia of the latter, which Iyengar calls dwarf female plants.

The quadriciliate macro-zoospores of *C. scytonemoides* with female potentialities show certain resemblances with quadriciliate macro- and micro-zoospores of *Ulothrix*. While in *Ulothrix* the macro- and micro-zoospores serve the purpose of vegetative multiplication only and sexual fusion is seen only among isogamous biciliate gametes, in the case of *C. scytonemoides* sexuality is evolved in the macro- and microzocspores as well, the former producing a non-motile oosphere or macro-gamete and the latter producing two to four micro-gametes or antherozoida.

M. S. RANDHAWA.

Collector's House,
Agra,
June 3, 1941.

[1] Randhawa, M. S., *Proc. Ind. Acad. Sci*, 1936, **B4**.
[2] —, *Hedwigia*, Dresden, 1939, **78**.
[3] Iyengar, M. O. P., *Curr. Sci.*, 1934, **8**.

OBSERVATIONS ON *BALANTIDIUM COLI* (MALMSTEN)

EXTENSIVE work has been done in different parts of the world on *Balantidium coli* (Malm.) which has been reported from the intestine of pigs, monkeys and man. We had the opportunity of examining the gut contents of the gibbon, *Hylobates hoolock* (Harlan) which died in the Zoological Gardens, Calcutta. We found it heavily infected with *B. coli*. A remark on its morphology together with the boring apparatus is described here.

The ciliate in this host measures 40–70μ in length and 35–50μ in breadth. They are more or less ovoid in shape with the anterior extremity narrower than the posterior. The macronucleus varies from 14–26μ in size and is either straight or in the form of a horse-shoe shape, while the micronucleus, which varies from 3–5μ in diameter, is subspherical in shape and lies in a notch near the middle region of the macronucleus. In the majority of the specimens there are two contractile vacuoles, one situated at the posterior end and the other near the middle of the body close to the macronucleus.

In the region of the peristome in *B. coli* and *B. suis* existence of a definite system of intracytoplasmic fibres termed as 'neuromotor apparatus' was shown by McDonald.[1] It included a J-shaped motorium in the ectoplasm close to the œsophagus in addition to the fibres, which

are directly or indirectly connected with it. McDonald[1] considers that the thickened ectoplasm and the movement of the cilia of the peristomial region are correlated with their feeding and also with their ability to penetrate into the mucosa of the intestine. He points out that the pellicle and the ectoplasm of the anterior region of the ciliates are thicker than any other part of the body and the cilia of this region beat spirally producing a boring action. Ray[2] also observed in *B. sushilii* in the region of the peristome, a system of fibres, which he described under two heads: the axial and the peripheral system of fibres. According to him the former, together with a knob-like structure at its anterior end, called the borer, constitutes the boring apparatus, since by means of this the parasites bore their way into the intestinal epithelium.

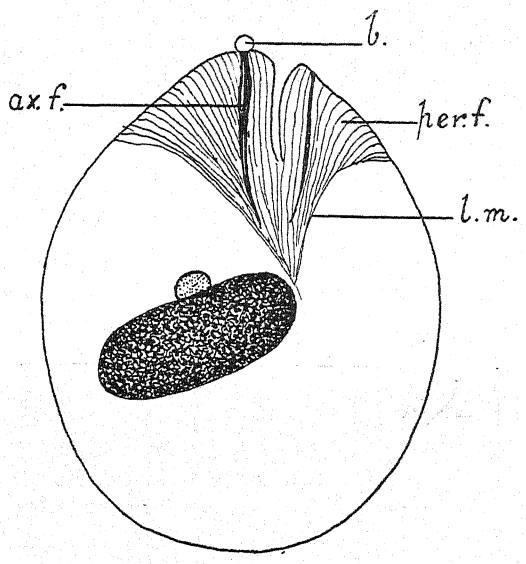

FIG. 1

B. coli from *H. hoolock*. × 1666. *ax. f.*–axial system of fibres; *b.*–borer; *l.m.*–limiting membrane; *per. f.*–peripheral system of fibres.

This same boring apparatus was also found by one of us (Chakravarty[3,4]) in *B. elongatum*, *B. helenæ*, *B. rotundum*, and *B. depressum*. We have examined the condition of the apparatus in the ciliate under report and give below the description of its component fibres and its bearing on the boring mechanism.

A group of fibres (*per f*), which corresponds to the longitudinal and peripheral fibres of McDonald[1] and Ray[2] respectively, is seen in this species on both the sides of the peristome arranged more or less obliquely. These fibres converge mesially towards the centre of the longitudinal axis of the body so as to form a sort of limiting membrane (*l.m.*) and in no case they pass beyond the centre of the body length. Schneider,[5] Ten Kate[6] and Ray[2] hold that these fibres have a supporting function lending rigidity to the body. We could not find here the J-shaped motorium described by McDonald in this species as well as in *B. suis*.

Besides the peripheral fibres there are two or three fibres on the left-hand side of the peristome comparable to the axial system of fibres of Ray.[2] The fibres arise from the base of a knob-like structure termed 'borer' by Ray[2] and pass posteriorly to meet the limiting membrane. They are spirally wound together forming a stout cord. The borer is situated just outside the pellicle but can be partially retracted within a notch in the pellicle. We also find a few fibres attached beneath the pellicle similar to those found by Chakravarty[4] in *B. depressum*. These should also be included under the axial system of fibres.

Since we fail to find any neuromotor apparatus as reported by McDonald[1] and the ciliates actually bore through the epithelium of the intestine we are in favour of regarding the knob and the associated fibres both of peripheral and axial system as forming together the boring apparatus.

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A. N. MITRA.

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Calcutta,
May 2, 1941.

[1] McDonald, J. D., *Univ. Calif. Public. in Zool.*, 1922, **20**, N. 10.
[2] Ray, H. N., *Jour. Roy. Micros. Soc.*, 1932, **52.**
[3] Chakravarti, M., *Curr. Sci.*, 1933, **1**, No. 2.
[4] —, *Arch. Protistenkde*, 1936, **87.**
[5] Schneider, K. C., *Arb. a. d. Zool. Inst. d. Univ Wien u. d. Zool. Stat. Triest*, 1906, **16**.
[6] Ten Kate, C. G. B., *Arch. Protistenkde*, 1927 **57.**

EMASCULATION IN CHILLIES (*CAPSICUM* GENUS)

EMASCULATION, the first and the most important operation, to be attended to during the process of hybridization entails a good deal of care and precaution on the part of a plant-breeder. More often it is done by completely removing the stamens, one by one, by forceps or by a pair of scissors, before the anthers begin to burst and just at the time the flower begins to open. This method of removing the anthers takes some time and often, in spite of the several precautions taken, there may be a likelihood of one or more stamens being left in the flower, specially in those where a large number of stamens have to be removed.

In chillies the stamens are all epipetalous, and the corolla is so brittle that the tubular corolla can easily be removed without any injury being caused either to the ovary, the style or the stigma. When the fully matured bud, which is expected to open the next day, is split at the corolla to remove the anthers one by one, it was found that in some cases the tubular corolla, being brittle fell off easily, leaving intact the gynæcium. This led us to try if the epipetalous corolla tube (Fig. 2) cannot be removed wholesale instead of attempting to remove the stamens one by one.

The pedicel of the flower is held, in between the thumb and the fore-finger of the left hand, with a careful and firm grip of the calyx enclosing the ovary, and with the right-hand thumb and forefinger the tubular corolla is cautiously removed without applying much pressure lest any damage should be done to the style and the stigma (Fig. 1). It is quite gratifying to note that this method of emasculation gave as much percentage of setting as the other (removal of anthers by forceps, etc.) with the one great advantage of saving good amount of time.

Detailed data regarding the number of flowers that could be operated in a fixed time by both the methods and the percentages of setting is being collected. At any rate, that

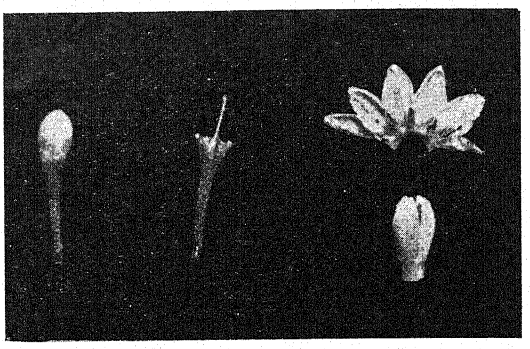

FIG. 1

the process of removing epipetalous corolla tube is found to be much quicker and easier than removing the stamens one by one, is established beyond doubt.

FIG. 2

It may not be out of place to mention here, that even illiterate coolies, specially women with delicate hands, were able to do this operation with the greatest amount of confidence and success giving a very good percentage of setting. Preliminary trials are being conducted with tobacco flowers also where the results are quite encouraging and the same may be found suitable for most other epipetalous flowers.

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April 16, 1941.

VEGETATIVE PROPAGATION OF MANGO FROM GOOTES (MARCOTTE) AND CUTTINGS BY TREATMENT WITH HIGH CONCENTRATION AUXIN

In a previous communication[1] the result of the preliminary experiment on the root formation in mango gootes, by application of 1 per cent. indole acetic acid, was reported. The experiment was further continued and it has been possible to successfully raise plants, by the above method, from 80 per cent. of the gootes taken from young plants of two and three years old.

Experiments were also undertaken to propagate plants from cuttings of mango and it has been possible to do so from cuttings of two- and three-year old plants by treatment with 3 per cent. indole acetic acid. In the present experiment the ring of bark from the twig, from which the cutting was to be made, was removed and treated with lanoline sclution of auxin, quite similarly as the gootes were treated. After twenty-four hours of such treatment the twig was severed from the mother plant at the lower end of the ring and planted in soil in a slanting position. Photograph of one such cutting taken cut of the soil, after seven months of treatment, is given in Fig. 1, to show the induced root formation. There was no root formation in the untreated ones which died after a certain time. One per cent. indole acetic acid induced slight root formation in some of the cuttings, whereas, 1 per cent. and 3 per cent. naphthalene acetic acid were ineffective in producing roots.

When the mother plants were aged, propagation by the above methods was not successful. Though Auxin treatment induced root formation in the gootes of such plants, the time taken for root formation was comparatively much longer and the number of roots produced much fewer, being quite insufficient for the independent existence of the goote in the soil. In the cuttings of the aged tree auxin treatment induced no root formation.

It has been concluded that the age of the mother plant has some influence on the root formation in gootes and cuttings of mango by treatment with auxin. Further attempts will, however, be made to investigate means of overcoming the difficulty of such propagation from old plants.

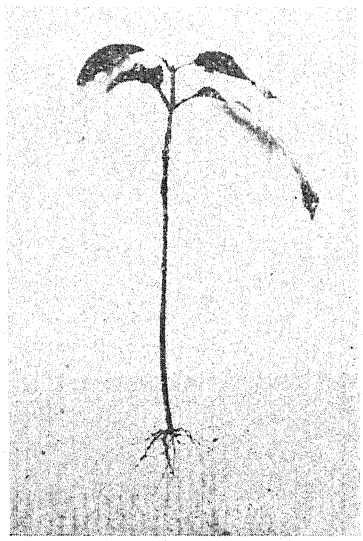

Fig. 1

Photograph of mango cutting, showing root formation by treatment with lanoline solution of 3% indole acetic acid.

Photograph taken after 7 months of treatment.

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B. K. Dutt.

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Calcutta,
May 5, 1941.

[1] Guha Thakurta, A., and B. K. Datt, *Curr. Sci.*, 1940, **9**, 77.

A NOTE ON THE EMBRYOLOGY OF *SCOPARIA DULCIS* LINN. AND *ANGELONIA GRANDIFLORA* C. MORR.

Srinivasan[1] has recently published a paper on the embryology of *Angelonia grandiflora* and some other plants of the Scrophulariaceæ, in which he makes the following statement regarding *Angelonia*: "The antipodals are ephemeral and degenerate soon after fertilisation. The

behaviour of the synergids after fertilisation is interesting. They do not degenerate after fertilisation, as in the case of the other members of the family, but persist till comparatively late stages in the development of the embryo. The synergids are seen clearly in post-fertilisation ovules, which have increased in size considerably." Further, on pp. 216–7 of the same paper, the author writes that "so far as is known, the only other genus of this family, where haustoria do not occur is *Scoparia*.[2]" On looking up the paper of Schertz one finds that he has worked on *Scrophularia marylandica* but incidentally mentions that in *Scoparia* no haustoria are "noticeable".

Rāghavan and Srinivasan[3] think that the statement made by Schertz is justifiable on the basis of Srinivasan's work on *Angelonia* and add the suggestion: "It is quite likely that in such of those few forms, where true endospermal haustoria do not occur, the synergids come forward and take up the role."

The presence of persistent synergids and the lack of endosperm haustoria in a member of the Scrophulariaceæ seemed so unlikely that immediately on reading the above, we decided to investigate the point ourselves. Material of *Scoparia dulcis*, fixed several years ago at Agra and Allahabad and imbedded in paraffin, was available in abundance and about a hundred ovaries of different stages of development were sectioned. In no case did we find any haustorial synergids. They are certainly quite prominent in pre-fertilisation stages but begin to degenerate soon afterwards and disappear long before any divisions have taken place in the zygote. Endosperm haustoria, both chalazal and micropylar, are present as usual. A detailed report will be published elsewhere.

Unfortunately, the material of *Angelonia* that was available to us showed only prefertilisation stages which go through normally. The flowers fall off soon after opening and although the ovaries sometimes showed a little swelling, sections revealed only degenerated embryo-sacs. It may be noted that at Dacca this plant is propagated entirely by cuttings.

A study of Srinivasan's figures shows that not only are the synergids persistent (Figs. 20–23) but the endosperm consists of a single row of about half a dozen cells (Fig. 20) which later divide in all planes to form an irregular mass (Figs. 21–23). It is disappointing that Srinivasan does not figure the first and second divisions of the primary endosperm nucleus in *Angelonia*, although he regards his study of this plant as the main contribution of the paper. A much closer series of figures is given in the case of *Dopatorium*, *Stemodia* and *Vandellia*, although they are essentially normal and, judging from the title, form only a subsidiary part of his work.

We believe that *Angelonia* should be re-investigated, preferably with the help of material obtained from its native habitat. If the abnormalities reported by Srinivasan are substantiated, it will certainly have to be regarded as a *very* aberrant member of the Scrophulariaceæ.

Incidentally it may be mentioned that Srinivasan's method of grouping his figures and giving their legends puts the reader to the maximum amount of inconvenience. For example, the explanation for Fig. 28 follows that of Fig. 33, while this in turn is followed by Fig. 35. Fig. 34 follows Fig. 36, while no legend whatever could be found for Fig. 38.

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Dacca,
May 10, 1941.

P.S.—After this had been written out, we received the April number of *Proc. Ind. Acad. Sci.*, 1941, 13, containing a paper by Raghavan and Srinivasan on *Scoparia*. This confirms our own observations on the plant and we hope that the authors will now re-investigate *Angelonia*.

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[1] *J. Ind. Bot. Soc.*, 1940, **19.**
[2] Schertz, *Bot. Gaz.*, 1919, **68.**
[3] *Proc. Ind. Acad. Sci.*, 1941, **B 13.**

DISCOVERY OF CELESTITE IN THE TRICHY DISTRICT

IN a recent publication of the Geological Survey of India,[1] Dr. Krishnan has made some erroneous observations on the discovery of celestite in the Trichinopoly District.

The Trichy Mining Works did not at any time send to the Indian Institute of Science any specimens of celestite for analysis; the 'lump' referred to in our note in *Current Science*[2] was picked up by me for examination while on a tour in the area of occurrence. The Trichy Mining Works, therefore, cannot be credited with any share for the discovery of celestite. It must also be pointed out that our estimate of one million tons of celestite as published in *The Hindu* (daily edition 4-1-1940), refers to the whole area and not to the restricted area of 1,500 acres.

Regarding Dr. Warth's observation on the occurrence of celestite, his note was not in any published form, but remained in the Government files only. Therefore the claim of the authors[2] for the discovery of celestite, cannot be invalidated, as has been attempted by Dr. Krishnan.

In this connection, Dr. Krishnan[3] is again wrong in quoting us as stating that both *strontium sulphate* and strontium carbonate occur as thin plates filling the cracks in the phosphatic nodules collected from Utatur area. We have made no reference to strontium carbonate, but reported only celestite. Our estimate of the celestite in the phosphatic nodules, as up to 3 per cent. and "even 10 per cent. in exceptional cases" is in no way high. Our estimates are based on systematic quantitative physical and chemical studies of large quantities of phosphatic nodules, and not on the basis of the rough "hammer tests". There has been besides no mistaking of gypsum for celestite, as gypsum occurs mainly in the non-phosphatic nodules while celestite, as a rule, occurs in the phosphatic nodules.[4]

Finally, the statement of Dr. Krishnan about a possible mistaking of fibrous calcite for strontianite is quite unfounded. I have clearly noticed the widespread occurrence of the brown fibrous calcite. Strontianite occurs, though only to a limited extent and largely mixed up with celestite and other impurities, as small grey or yellow fibrous, or earthy appearance, and has been identified only after detailed chemical studies. It has never been maintained that strontianite occurs in enormous quantities in the Trichy area.

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Indian Institute of Science,
Bangalore,
June 4, 1941.

[1] *Rec. Geol. Surv. Ind.*, 1941, **76,** Bull. No. 3, 9 and 10.
[2] *Curr. Sci.*, 1939, **8,** No. 12, 553.
[3] G. O. No. 735, (10-4-1941), Development Dept., Government of Madras.
[4] *Jour. Ind. Inst. Sci.*, 1940, **23A,** Part II, 11–20.

PROF. BAWA KARTAR SINGH

WE have great pleasure in congratulating Professor Bawa Kartar Singh, M.A., Sc.D. (Cantab.), Sc.D. (Dublin), F.I.C., I.E.S. (Retired), of the Allahabad University, on the award of the Sc.D. degree of the Cambridge University. This is an exceptional distinction and is a just recognition of the great services rendered by the Professor to the advancement of chemistry and chemical education in India. After a distinguished career both in India and in England, Prof. Singh served respectively at Dacca, Lahore, Cuttack and Patna, before being called upon to occupy the Chair of Chemistry at the Allahabad University in 1940. Wherever he was, his abounding enthusiasm for research outstripped the limitations of heavy administrative duties and any lack of facilities for research, and resulted in a volume of work on optical activity, phototropism, optically active dyes, and other chemical subjects. Prof. Singh has earned several academic distinctions. He was President of the Chemical Section of the Indian Science Congress in 1920, President of the Indian Chemical Society 1931–32, and Vice-President of the Indian Academy of Sciences 1934–40.

REVIEWS

Methane, Its Production and Utilisation. By J. P. Lawrie. With a Foreword by Lord Strabolgi. (Chapman & Hall, Ltd., London), 1940. Pp. 66. Price 6*sh.*

This book is a publication of topical interest. Frequent attempts have been made to use methane as an alternative to petrol in countries which do not command natural resources in mineral oil. It is stated that in Germany alone 22,000 vehicles have been converted to operate on methane gas in the last two years. French manufacturers have developed a gas container weighing 245 lbs. which can hold 700 c.ft. of methane gas at 3,000 lbs. per square inch pressure equivalent to 5 gallons of petrol. The use of this gas as fuel for stationary engines is also rapidly increasing.

Dr. Lawrie has made out a very good case for the development of the potential supplies of the gas from collieries, coke-ovens, and also from the biological treatment of sewage. In India, this biological process has a special significance for national economy both in times of peace and war. In this connection the work of Barker on methane producing bacteria is stated to be quite promising. Figures from one of the largest sewage works in Europe—The Mogden Works of the West Middlesex Drainage—indicate that it is possible to produce 1,350,000 c.ft. of this gas per day for a population of 1,250,000 and use a large portion of this gas for the generation of power. This book is commended to industrialists and public health authorities for careful perusal. J. C. G. and S. C. P.

The Travancore Tribes and Castes. Vol. III. *The Aborigines of Travancore.* By L. A. Krishna Iyer. Trivandrum, 1941. Pp. 176 + x. Price Rs. 5.

With the present volume the work on the ethnography of Travancore which the author undertook some years ago comes to its conclusion. What his father, the late Dr. L. K. Anantakrishna Iyer did for Cochin and Mysore, Mr. Krishna Iyer has now done for Travancore, and he has done it with an enthusiasm which is specially required in a rapidly expanding science such as Anthropology, and with a receptiveness to criticism which is not a very common virtue among the tribe of scribes. In the present volume he gives a generalised summary of such topics as tribal traditions, racial affinities, megalithic monuments, domestic life, exogamy, marriage, taboo, inheritance and social organisation, disposal of the dead, religion, occupation and clash of culture, most of which have been discussed separately under the different tribes in the previous two volumes. The last chapter on clash of culture is of special importance as it deals with some of the most crucial problems intimately connected with the future of these tribes. Apart from its value to the academic anthropologist, books like this are "of inestimable value in pointing out to the Hindu majority the condition of their less advanced fellow country-men and, even of greater importance, those elements of tribal culture which are of permanent survival value".

Prof. Marett contributes a brief but interesting introduction with several suggestions for the benefit of the educated youth of India. In commending a closer study of the diverse types of Indian communities to young Indians, he remarks how ignorant he has found the brilliant young Indians who find their way to Oxford to be, of "their own country and its inhabitants, apart from their own home quarters and home-circle". He prescribes anthropology as a remedy against the narrowness of social outlook prevalent in India. A. AIYAPPAN.

A Manual of Aquatic Plants. By Norman C. Fassett. (McGraw-Hill Publishing Co., Ltd.), 1940. Pp. 382. Price 26*sh.*

The aim of the book is to enable the identification of aquatic plants in a sterile as well as in a flowering or fruiting condition. The region covered is from Minnesota to Missouri and eastward to the Gulf of St. Lawrence and Virginia in the United States. The aquatics of this area when thoroughly dealt with easily serves a much wider area since there is a great similarity or even an identity in the case of several of the aquatics with those of the neighbouring areas. The book is illustrated with good photographs and line drawings of the different plants.

In the first part of the book an excellent key is given, with the aid of which it is possible to run down the names of the plants to be identified. In this key the vegetative structures of the plants are very largely used to help one in the identification, while at the same time the distinctive features of the flower or the fruit are also referred to wherever necessary.

The second part forms the descriptive portion of the plants. In this part, the various plants are dealt with under the different families. Under each family a key is provided for the different genera and under each genus a key is given for the different species.

In the third portion of the book very interesting and useful information—the results of careful field observations—is given regarding (1) the uses of aquatic plants by birds and mammals, (2) the relation of plants to fish and (3) a general animal index in which is indicated the species of plants eaten by each animal. A good bibliography, a glossary and an index are given finally at the end.

The book will form a very useful reference book to the systematist or the ecologist who is interested in aquatic plants. Though the book deals only with the aquatic flora of a portion of the United States, the Indian reader also will find much to interest him owing to the many common features seen in the aquatic flora of our country.

M. O. P. I.

Chemical Composition of Foods. By R. A. McCance and E. M. Widdowson. (His Majesty's Stationery Office, London), 1940. Second Impression. (Medical Research Council, Special Report Series, No. 235.) Pp. 150. Price 4*sh.*

The recent rapid progress in the field of nutrition has brought home the fact that a knowledge of the chemical composition of foods is the first essential in the dietary treatment of disease or in any quantitative study of human nutrition. Sherman's Tables of Food Values, with their many limitations, have constituted so far the most important source of information. Drs. McCance and Widdowson have placed the world under a deep debt of gratitude by bringing out an extensive and authoritative book of great utility. Their book represents the solid and unostentatious work of a team of investigators working for fourteen years under the auspices of the Medical Research Council. Nearly 670 foods have been exhaustively analysed, and more information has been made available by them than that contained in Sherman's Tables. The foods have been analysed not only in the raw state but also as prepared for the table; the analytical figures have been rendered more valuable by the inclusion of the percentage of edible matter in the cooked food. Tables include a description of the food, nature of edible material, edible matter, water, unavailable carbohydrate, sugar, starch, total nitrogen, protein nitrogen, fat, available carbohydrate, calorific value, sodium, potassium, calcium, magnesium, iron, copper, phosphorus, sulphur, chlorine and acidity or alkalinity. In the case of flesh foods, purine nitrogen values are also given. Analysis has also been made of a number of cakes, pastries, puddings, etc., made to standard recipes and described in 14 special pages.

A few pages have been devoted for figures of the various ingredients contained per ounce of the food; this is in addition to the more commonly expressed values per 100 grammes. Figures per ounce have a greater appeal to the laity than percentages. Available phosphorus expressed as a percentage of the total phosphorus and "available" iron also expressed as a percentage of total iron for a few of the foodstuffs are included at the end of the book.

The book should equally prove an invaluable guide to those interested in the dietary treatment of disease and to those engaged in the serious study of human nutrition. This phœnix of quantitative knowledge condensed in 150 pages will undoubtedly constitute what must remain for many years to come the most authoritative Tables of Food Values. The format of the book leaves little to be desired. S. R.

An Inorganic Chemistry. By H. G. Denham. Third edition. (Edward Arnold & Co., London), 1939. Pp. 694. Price 12*sh.* 6*d.*

The book is written in a simple and lucid style. It contains sufficient information for those taking intermediate science in chemistry. The subject is divided into three groups, theoretical, non-metals and metals. The fundamental principles which an

intermediate student ought to learn at this stage are clearly explained with appropriate illustrations. The inorganic chemistry proper under non-metals and metals has been dealt with great discrimination. The experiments which have been described under the study of non-metals and metals are just the experiments which a lecturer requires for demonstrations. The book would have been more appreciated if it had included a chapter on recent advances treated in a popular manner. S. V. R.

The Grasslands of the Argentine and Patagonia. (*Herbage Publication Series, Bulletin* 30.) (Published by the Imperial Bureau of Pastures and Forage Crops, Aberystwyth), 1940. Pp. 49. Price 2*sh.* 9*d.*

This bulletin is the report of a tour of South American Grasslands undertaken during early 1938 by a well-known agrostologist.

A wide range of climatic types have been covered ranging from sub-tropical in the north to cold temperate in the south.

Eight pastoral zones are described in simple non-technical language with a covering map showing their distribution, and each zone is briefly discussed in relation to its vegetation, agricultural or pastoral practices and potentialities.

There follows a series of notes on 23 individual stations visited. Nineteen, rather mediocre, illustrations help the reader in reaching a proper appreciation of the variety of conditions met with.

Dealing as it does mainly with a description of professional large-scale ranching conditions and practices on pastures whose botanical composition differ vastly from our tropical pastures the *Bulletin* is of only limited interest to Indian readers.

It is however worth more than a passing glance if only to bring home once again the ever present menace of soil erosion where mismanagement of land takes place in the struggle to realise immediate profits.

In this case it is very striking that the intensive raising of lucerne leys which have to be reconstituted at frequent intervals has resulted in considerable loss of fertility through failure to return soil losses by adequate manurial treatment and in wind erosion on an extensive scale. 70 years ago the average area under lucerne was 250,000 acres. 20 years ago it had risen to 21,000,000 acres, but during the last few years this tremendous area has shrunk to 13,500,000 acres in 1933–34 owing chiefly to the compulsory retirement of lands once cultivated through drifting sand. When it is realised that the Argentine is dependent on lucerne for final fattening off of her vast herds, the loss of these areas becomes a serious matter, for their recovery is usually beyond the pocket of the private owner and has to be left to the State.

Such examples as this cannot receive too much publicity in India, where erosion is already depleting the basic national capital —soil fertility. J. A. WILSON.

The Breeding of Herbage Plants in Scandinavia and Finland. (*Herbage Publication Series, Joint Publication* No. 3.) (Published by the Imperial Bureau of Pastures and Forage Crops, Aberystwyth), 1940. Pp. 124. Price 4*sh.*

This joint publication of the Imperial Agricultural Bureaux presents the translations of seven papers on the breeding of herbage plants (grasses and pasture legumes) by seven authorities from Sweden, Denmark, Norway and Finland.

This type of work has been in progress in both Sweden and Denmark since the early years of this century, while in Norway and Finland a start was made some 20–30 years later.

Covering these translations is a rather lengthy summary, indicating the lessons to be drawn from breeding work in these northern countries. Each individual crop is dealt with separately.

The highly technical nature of the work described makes it impossible to avoid the extensive use of that technical jargonese which has now become standardised and which—rather unfortunately in my opinion —renders the intelligent assimilation of the subject-matter difficult to the lay reader.

To the plant breeder, however, the publication is of great interest in indicating the aims and objects kept in view in respect of each crop, the methods employed, and the results obtained.

In India, where the breeding of pasture grasses and pasture legumes is almost an unexplored subject, basic issues will have to

be dealt with before proceeding to the more technical work, and such work receives only passing mention.

An interesting account of cytological work done in Sweden during the past 10 years is given. This had for its main object, a systematic endeavour to alter the chromosome number in crop plants so as to obtain more valuable types for cultivation, and was based on various findings, chief among which are those of Müntzing, who found that both auto- and allo-polyploid types *as a rule* are remarkable for a more vigorous type of growth than original types, and that when the chromosome number varies within the cultivated forms of one and the same species, the high chromosome types are universally the most valuable. The four methods by which a change in chromosome number has been brought about are briefly described and this paper is of particular interest to the plant breeder, though it may not belong strictly to his sphere of work.

J. A. WILSON.

THE INDIAN STATISTICAL INSTITUTE

STATISTICAL method and statistical studies have now, without doubt, gained place of importance in academic thought as well as in administrative work. They have even bifurcated themselves already into two almost distinct branches, one chiefly descriptive and enumerative which is connected with economics and administration, and the other primarily analytical which is as much a branch of positive science as applied mathematics. In Europe statistics became a serious subject of study with the rise of modern States and for a long time almost exclusively associated with economic studies. Not until the mathematical theory of errors based on normal distribution was employed in reduction of observations in astronomy (Gauss), anthropology (Quetelet), or even until the ideas of correlation P, χ^2, and exact distribution were extensively used (Galton, Pearson), was a revolution brought about in the world of statistics. Even more recent work such as at Galton Biometric Laboratory in London, Lawes Institute at Rothamsted, Lund Observatory in Sweden, with which many living statisticians are associated, has definitely enthroned statistical analysis as the touchstone in all experimental work in which a multiplicity of factors is a predominant feature. Societies for the scientific study of statistics exist in all important countries, and the oldest among them, the Royal Statistical Society of London, has already celebrated its centenary.

Statistical studies in India may be traced to classic period of Sanskrit Culture, and to Kautilya's *Arthasastra,* or *Ain-i-Akbar,* and brought down to 1871 when the Government of India opened a separate Commercial Intelligence Department. In modern times the Government of India have made extensive arrangements for the collection of a large amount of primary statistics relating to agriculture, population, public health, vital statistics, finance, trade and commerce, transport, meteorology, and various other things of departmental or semi-analytic kind. On *ad hoc* basis advanced studies and researches particularly in analytic statistics were being done by various persons in the country, and not until 1931 was the question of starting a society even discussed by the workers. In that year a draft constitution for an All-India Statistical Institute was printed and received favourably, and on the 29th February 1932, it was actually put into operation with the Headquarters of the Society at Calcutta. The Ninth Report of this Society embodying the work for 1940–41 has just been published.

As in previous years the work of the Institute consisted of four distinct departments, Statistical Inquiries, Training and Examinations, Research, and Annual Conference.

A large number of enquiries from all parts of India was attended to during the year under review. The distribution by subjects and by provinces is given below:—

By Subjects: Agriculture 81; Anthropology 3; Economic and Business Statistics 30; Education 17; Forest Research 7; Industry 11; Mathematical Statistics 12; Medical 20; Meteorology and Irrigation 14; Miscellaneous 20. Total 215.

By Provinces: Assam 10; Bengal 86; Bihar 2; Bombay 9; C.P. 6; Central Government 31; Madras 6; Orissa 5; Punjab 7; Sind 8; U.P. 33; Others 12. Total 215.

During last year 16 officers from Bengal, Bombay, Burma, U.P., Punjab, and Sind came on deputation to the Institute for training in statistical theory and technique. Mr. K. Raghavan Nair was in charge of this section. The examinations for Statisticians' Diploma Part I and Computer's Certificate Part I were held from 8th to 12th January 1941. There were nine candidates for the diploma and three for the certificate examinations. The Board of Examiners consisted of Prof. K. B. Madhava (Mysore University), Dr. P. V. Sukhatme (Delhi), Mr. R. C. Bose (Calcutta University) and Prof. P. C. Mahalanobis.

Theoretical researches were focussed on the following topics: (1) measures of statistical divergences with appropriate exact distribution; (2) design of experiments; (3) design of large-scale sample surveys and model sampling experiments with non-normal populations. Under the leadership of S. N. Roy the sampling distribution on the null (or equal dispersion) hypothesis of a set of p-statistics which form the appropriate measure of the divergence in the case of multi-variate problems was worked out. The case of heterogeneous dispersion was also investigated. Prof. Fisher in a letter written in 1940 characterised this work as one of the most important recent advances in Statistics. Imported contributions were made to the mathematical theory of the design of experiments by R. C. Bose, K. R. Nair, K. Kishen and others. Interesting relations were obtained between fundamental simplex at infinity in space of n-dimensions and components of main effects and interactions which marked an advance towards the solution of the problem of confounding in the general factorial design. The sampling survey, which is now recognised to be the most efficient method for large-scale enquiries, has continued to engage a good deal of attention; and important advances have been made in the technique of such surveys. The mathematical theory is based on the joint use of two important functions, namely, the variance (or error) function and the cost function. The chief object is to determine the optimum size and number of sample units and the best way of distributing them over the whole area under survey in such a way that the precision of the final results may be as high as possible at any assigned level of expenditure. This method has been applied to jute census, paddy, sugarcane, wheat and other crop estimating survey.

The Fourth Session of the Indian Statistical Conference was held at Benares, 1941. It was opened by His Excellency Sir Maurice Hallet, Governor of the United Provinces of Agra and Oudh. The Hon'ble Sir Girja Shankar Bajpai, Member-in-Charge of the Department of Education, Health and Lands, Government of India, in his address as General President emphasised the social value of Statistics. He exhorted statisticians to proclaim their purpose and explain their activities in language that was intelligent to the ordinary citizen; and pointed out the need for generous financial support from Government and public-spirited industrialists and persons interested in national welfare. Numerous papers were read. Also several joint sessions with the Indian Science Congress were also held; with Anthropology Section (Prof. K. P. Chattopadhya presiding), with Mathematics and Statistics (Dr. C. W. B. Normand presiding), Medical Section (Dr. J. B. Grant presiding), Agricultural Section (Mr. K. Ramiah presiding). Discussions on Applied Economics with Prof. K. B. Madhava in the chair and on Teaching of Statistics with Prof. V. V. Narlikar in the chair were also conducted.

The work of the Institute in the matter of popularising the study of Statistics among students and businessmen was spread over in the five local branches at Bombay, Poona, Madras, Mysore and Lahore, but the chief developments were at Headquarters of the Institute in Calcutta under the direct guidance of the selfless and indefatigable Secretary, Professor P. C. Mahalanobis. His devotion, his work and enthusiasm has received the continuous and sustained support from all academic persons as well as important departments of the Provincial and Central Governments; in particular, this year he was appointed Chairman of the Nagpur Textile Enquiry Committee by the C.P. Government to examine the question of dearness allowance, and was also member in the Indian Central Cotton Committee, Imperial Council of Agricultural Research, Special Entomological Committee, Bengal Board of Economic Inquiry Committee, Bengal Agricultural Research Committee, Price Control Advisory Board of Bengal and several others.

K. B. MADHAVA.

ROSHA GRASS OIL

BY
PROF. JAI CHAND LUTHRA
(*Punjab Agricultural College, Lyallpur*)

A NUMBER of oil-yielding grasses are found in India. The more important of these are:

1. *Cymbopogon martini* Watson (Motia and Sofia varieties).
2. *C. nardus* Rendle (Citronella oil).
3. *C. citratus* Stapf (Lemon grass).
4. *C. flexuosus* (Nees) Watson.
5. *C. schocnanthus* Spreng (Camel grass oil).
6. *Vetiveria zizanioides* Nash (Khaskhas).

C. martini Watson is widely distributed in India and its use as a fragrant oil appears to date back to an early period. The refined product is technically known in the trade as Palmarosa oil.

India has been exporting Palmarosa oil for many years to Europe and America and has had almost a monopoly of it. Palmarosa oil is used as a base for the manufacture of perfumes on account of its principal constituent Geraniol of which it contains about 90–95 per cent. It is also used for scenting toilet soaps. The demand for Indian Palmarosa oil has declined a good deal on account of other countries, *e.g.*, Java, having taken up the cultivation of Citronella grass as a source of Geraniol. The Rosha grass oil is, however, of superior quality and fetches higher price. But in spite of this advantage, India appears to be losing its overseas market. The position, therefore, requires attention. In some parts of India the manufacture of perfumes has been started and Palmarosa oil has begun to be used for that purpose. With the availability of this oil there is obviously a great scope for such industry here.

To establish the industry on a firm basis it is necessary to cultivate the grass, because not only will the yield be increased by cultivation but also the selection of the variety *motia* will ensure supplies of the best type of geraniol. The late Prof. Puran Singh, Chief Chemist, Forest Research Institute at Dehra Dun, realised that there was a future for this industry. He obtained 400 acres of land on lease and laid out a plantation near Lyallpur in 1924. He succeeded in establishing the grass over an area of 230 acres. He put up a Steam Distillation plant and 3,000 to 3,500 pounds of Palmarosa oil were produced annually. This was the first example of cultivation of an Essential Oil Grass in India. The Punjab, however, does not provide the best conditions for growing it. It is subject to severe frost which kills the grass and reduces its oil content. The grass is grown under canal irrigation and the cost of cultivation is also high on account of water and revenue charges. There are localities in other provinces more suitable than the Punjab and as it offers a great scope for a flourishing indigenous industry, experiments should be conducted for cultivating it. Places with an ample rainfall would be most suitable, as the cost will be considerably reduced.

Rosha grass is a perennial plant. It attains a height of about 6–8 feet. The aerial parts die in winter. Being very susceptible to frost, its leaves and shoots may dry up even in November when there is early frost, but usually withering starts in December, and by the end of January, the plant dries up completely. The dead stumps of the plants are burnt to make room for new shoots. The root stocks sprout in spring and by the middle of October the grass is in blossom and cut for distillation.

The flowers contain a higher percentage of oil (1·4 per cent.) than other parts. The leaves also contain about 1·4 per cent. oil while in the stalks, percentage is as low as 0·03. An acre of the grass yields 15–20 lbs. of oil. Frost causes a loss which may amount to 54 per cent.

Full analysis of a sample of palmarosa oil supplied to me by Dr. S. Krishna, D.Sc., Bio-Chemist, Forest Research Institute, Dehra Dun, U.P., is as follows:—

Colour and odour—Light yellow, pleasant odour.	
Specific Gravity at 20° C.	0·8822
Refractive index	1·4663
Angle of rotation	+ 0·21
Solubility in 70% alcohol	2·2 parts
Acid value	1·74
Ester value	14·93
Ester value after acetylation	276·27
Corresponding to:—	
Total geraniol	95·83%
Free geraniol	91·68%

Higher acid value indicates that some de-esterification has taken place, which is confirmed by the rise in free geraniol.

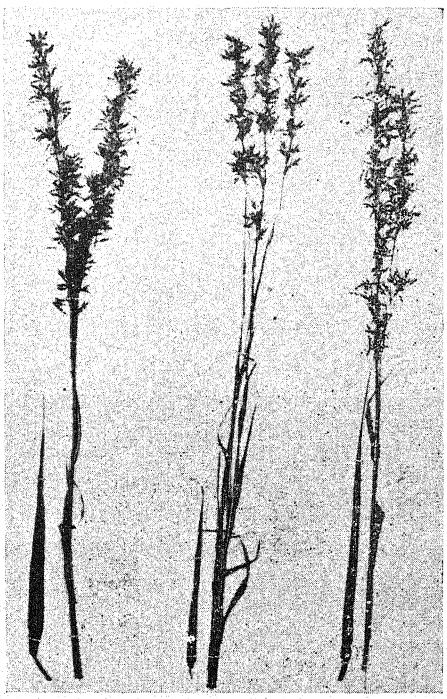
Botanical studies of the plantation have furnished important results regarding the type composition of the crop. As noted above, the typical plant possessing essential oil of the standard quality and purity is the motia variety of *Cymbopogon martini* Stapf. (Fig. 1). It has, however, been noticed that the grass raised from seed obtained from forests is a mixture of several forms. Eleven types differing in morphological characters have been distinguished. All these types are perennial and have almost the same period of growth as the motia variety.

Type No. 1.—Stalk, medium thick; height, over 6 feet; leaves, 6–10 inches long and green; internodes, 4–6 inches long; inflorescence, dense; spikelets, on slender long stalks. Flowers in early October.

This type is rich in palmarosa oil and gives the best yield. It is the typical motia variety.

Type No. 2,—Stalks, medium thick; height over 5 feet; leaves, thin, pale green and 6–8 inches long; internodes, 3–4 inches long; it is one of the early flowering types and has a long and lax inflorescence. Flowering starts in early October. Next to No. 1 in oil content.

Type No. 3.—Stalk slightly thicker than types No. 1 and 2; height, about 6 feet; leaves 10–12 inches long, dark green; internodes are 6–8 inches long. The inflorescence is borne on long slender stalks; spikelets, very lax. The inflorescence arises out of the axils of the upper leaves which decrease in size gradually towards the top.



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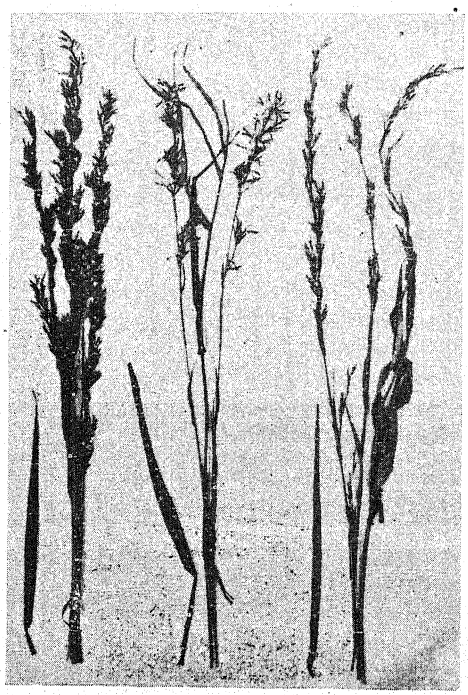
Types of Rosha Grass



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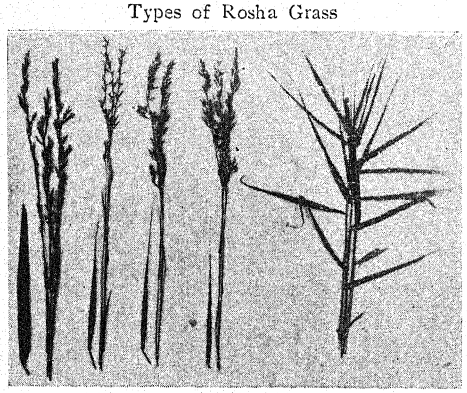
Types of Rosha Grass



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Types of Rosha Grass

Flowering starts early in October.

Type No. 4.—Stalk, coarse and thick; height, over 6½ feet; leaves, 10–12 inches long, very thick, dark green, with pointed sharp ends; internodes short and thick, 3–4 inches long. The inflorescence is borne on stout short stalks and is thick. It is a late flowering variety, and flowers in November.

Type No. 5.—A very conspicuous type with bluish red foliage; stalks medium thick; height, about 5½ feet. The leaves are 6–9 inches long, with closely clasping sheaths covering whole of the internodes, which are 4–6 inches long. It flowers late in December and bears very scanty flowers in lax thin inflorescences; oil content, poor.

Type No. 6.—Stalk, thick and coarse; height, over 6 feet; leaves thin, 8–10 inches long; internodes are 6–8 inches long. Inflorescence is very lax on long very thin stalks. Flowers in early November.

Type No. 7.—Stalk, medium thick; height, about 5 feet; very leafy; leaves dark green, ½–¾ inches broad and 8–10 inches long. Leaf-sheaths are long and clasping; internodes 4–6 inches long; flowering scanty; inflorescence is short and spikelets lax. Flowers in early October.

Type No. 8.—Stalk, thin, dwarf, bushy type; height 3½ feet only; leaves 4–6 inches long, light green, turning brown at maturity and are borne on closely sheathed internodes; 2–3 inches long. Inflorescence is very short and thin; glumes have reddish colour. Flowers in early November.

Type No. 9.—Another thin stalked, dwarf type, 3¾ feet high; leaves, short and pale green, 4–6 inches long, clasping the stalk rather loosely. The inflorescence is lax and scanty, borne on slender long stalks. Flowering starts early, about the middle of October or even earlier.

Type No. 10.—A thin stalked dwarf type only about 3½ feet high; leaves, scanty, green, 4–6 inches long, on long sheaths; internodes 3–4 inches long. It has got a short, medium dense inflorescence; flowers in October.

Type No. 11.—A very conspicuous dwarf type not exceeding 4 feet in height. Stalk, thick and covered with short, thick, pale-green leaves, placed at right angles more or less to the main stalk. Leaves are 8–10 inches long, and set closely together. Internodes are short, 2–3 inches long only. Very late flowering variety and is very poor in oil content. This is the Sofia variety.

CENTENARIES

Johnson, William Woolsey (1841–1927)

WILLIAM WOOLSEY JOHNSON, an American mathematician, was born of a lawyer and landowner at Owego, New York, June 23, 1841. He graduated at Yale in his twenty-first year and entered the United States Nautical Almanac Office. After two years, he became instructor in mathematics at the Naval Academy and remained as such throughout his life except for his sojourn as professor of mathematics at the Kenyon College, Ohio, during 1870–72 and at St. John's College during 1872–81.

Johnson was one of the founders of the American Mathematical Society. He was a popular lecturer and a clear writer. Between 1869 and 1901 he wrote seven books, of which Indian students would remember *A treatise of ordinary and partial differential equations* (1889). His most voluminous book was *The elements of differential and integral calculus*, 3V. (1874–76).

Johnson died May 14, 1927.

Cullingworth, Charles James (1841–1908)

CHARLES JAMES CULLINGWORTH, a British gynæcologist, was born of a bookseller at Leeds June 3, 1841. After school education and a few years' employment in his father's business, he had a brilliant career at the Leeds School of Medicine and became M.R.C.S. in 1865. After a short spell of private practice in rural areas, he entered the Manchester Royal Infirmary in 1867. His special work began in 1873 when he was appointed honorary surgeon to the St. Mary's Hospital for Women and Children at Manchester. In 1885 he became Professor of Obstetrics and Gynæcology in the Owen's College. In 1888 he migrated to London as obstetric physician of St. Thomas's Hospital.

In 1902 Cullingworth delivered the Brodshawe lecture on *Intraperitoneal hemorrhage incident to ectopic gestation*. He was one of the founders of the Obstetrical Society of London and of the *Journal of Obstetrics and Gynæcology of the British Empire*.

Cullingworth was prominent in the movement for the registration of midwives. When the Midwives Act came into force in 1902, he was appointed to the Central Midwives Board. He was a great pioneer in gynæcology. His most original book was *Clinical illustrations of the diseases of fallopian tubes and of tubal gestation* (1895). The views expressed by him in 1892 in a paper entitled *The value of abdominal section in certain cases of recurrent peritottis based on personal experience of fifty cases* were greatly discussed and were ultimately accepted.

Cullingworth died in London May 11, 1908.

S. R. RANGANATHAN.

University Library,
Madras.

THE INTER-UNIVERSITY BOARD, INDIA

THE brief Report of the Proceedings of the Sixteenth Annual Meeting (Trivandrum, 1941) of the Inter-University Board, recently published, contains as usual, several items of interest to those who are concerned with the development of higher education in India. It sets forth the opinions of the various universities of India on certain matters, and the decisions of the Board as a whole in regard to certain others. Special reference may be made here to three of the most outstanding problems considered by the Board: Military Training of university students, mutual recognition of degrees among Indian universities, and reorganization of secondary education.

In the present unsettled state of the world it is but natural that the question of imparting military training to students should have come to the forefront. Apart from the more general question of maintaining physical fitness among the educated classes, the problem of defending the country against foreign aggression seems to demand immediate consideration. In this connection, therefore, the Board has done well to suggest not merely the further extension of the presnt U.T.C. arrangements but also the introduction of military science as a subject of study in college classes. This is a sound move provided, of course, it is not thought that a nation can be rendered militarily efficient by reading about military matters in books.

The mutual recognition of degrees among Indian universities is undoubtedly a most desirable step. The want of such recognition has adversely affected students in the pursuit of higher education, retarding their free migration from one university area to another. After all, when the question is squarely put as to what has prevented, and still prevents, Indian universities from taking this step, perhaps the answer in most cases will be, not any desire to claim superiority, but some administrative trifle, or mere parochialism, which is altogether out of place in the academic world. The sooner this anomaly is removed the better for education.

The reorganization of secondary education is by far the most important question discussed by the Board. It is a problem, however, whose solution cannot be regarded as having been achieved, in spite of repeated consideration by the Board at three separate sittings. Resolution

XVIII recommends the bifurcation of high school studies into a vocational and an academic course; and in Appendix K is found the Press Communique of the Government of Madras setting forth the manner in which they have attempted to solve the problem for that province. It must however be pointed out in this connection that a merely educational approach to the problem is bound to fail; an economic apprcach is necessary. There is no use of turning out vocationally qualified persons unless vocations were made available for them.

Finally a word must be said about the language of the publication. In a Report which purports to set forth the deliberations of such a learned body as the Inter-University Board one expects that the English, like Cæsar's wife, must be above reproach. But apart from ridiculous printer's devils such as the 'Massage' of the Maharaja of Travancore (p. 4), there are other errors which ought not to have been allowed. Thus, for instance, 're' (p. 11) must be written in full as 'regarding', or it must be italicised; 'para' (p. 24) must be 'paragraph'; 'Inter' (p. 17) must be 'Intermediate'. Consider the wording of the following sentence (p. 10):

"It was also noted that if any University wants to nominate a representative in addition to those above mentioned at their own expense, the Board had no objection."

This sentence furnishes an excellent example of an exercise for correction (which may be set) in the English composition paper at the Intermediate examination of an Indian university.

D. S. GORDON.

SCIENCE NOTES AND NEWS

Archaeological Finds in Mexico.—The news of what is described as the "most spectacular" discovery in three seasons of Mexican explorations, has been announced by Matthew W. Stirling, leader of the Geographic-Smithsonian expedition, which recently carried out extensive excavations in Southeastern Mexico. According to a news bulletin issued by the *National Geographic Society*, a cache of more than 700 jade objects, including a number of human figures, pendants, axes, heads, large tubular and spherical beads and other objects, was unearthed.

The Geographic-Smithsonian expedition has been seeking clues to the origins of the ancient Indian civilizations of Middle America. In its first season it unearthed a colossal stone head, and a monument carved with Maya Indian symbols which scientists considered to be the earliest recorded date found so far in the Western Hemisphere. By one correlation that date is equivalent to November 4, 291 B.C., and by another, November 4, 31 B.C.

The Geological Origin of Burma.—Broadly speaking, the origin of Burma with its present configuration of land and sea and surface features can be traced back to an era starting from the Cretaceous period and ending at the close of the Tertiary era. It was during this period that the rising of the Himalayas from the Tethys sea took place. Burma, which had been subjected to a series of submergences and elevations, was still submerged during the early stages of this period. Just then huge tectonic movements, acting almost simultaneously with those which were responsible for raising the Himalayas from the floor of the Tethys, brought into being the Arakan Yoma range and the Shan plateau which even to-day are the most prominent features of the topography of Burma. Between these two was formed a central gulf elongated in a direction N-S and occupied by a shallow sea. The major portion of Burma as it now is, was then covered by this gulf which was connected to an ocean in the south. There is no evidence to prove that it was actually connected to the Tethys. (*Geol. Sur. Ind.*, 74, pt. 1.)

During the whole of the Tertiary era this gulf was being filled up with river-borne sediments from the north and by marine sediments in the south, with the consequence that the sea occupying this gulf slowly receded southwards and most of the 'Central Belt' of Burma became a land-mass by the close of the Tertiary era. At intervals this gradual infilling of the gulf was interrupted by light folding movements. It was in this gulf and at this period that the oil-bearing rocks of central Burma were deposited. N. JAYARAMAN.

***p*-Aminobenzoic Acid.**—A preliminary account of the experiments on the nutritional significance of *p*-Aminobenzoic acid has been published by Dr. S. Ansbacher in *Science* (1941, No. 2407, pp. 164–65). According to the data presented, this amino acid is a chromotrichia factor for the rat, and a growth-promoting factor for the chick, and is probably one of the factors of the vitamin B complex.

Hundred black or piebald rats at weaning age were placed on a basal diet and were given a daily supplement of thiamine hydrochloride, riboflavin, pyridoxine hydrochloride, calcium pantothenate, nicotinic acid, inositol, and choline chloride. Definite graying of the fur occurred. Seventy animals which later received a daily supplement of *p*-aminobenzoic acid recovered within a month while the remaining 30 rats reserved as controls, continued to show achromotrichia.

Experiments with chicks gave definite indication of the growth-promoting potency of this amino acid. Chicks reared on a heated vitamin K-deficient ration showed only a small gain in weight and died within a month, even when

adequate quantities of calcium pantothenate and 2-methyl-naphthoquinone were supplied. Addition of 300γ of p-Aminobenzoic acid to 1 gm. of ration resulted in better growth and the chicks continued to grow even after 2 months.

India's Mineral Resources and the War.—The more important mineral resources of a country, in relation to war are:—(1) *fuels* like coal and petrol, (2) snowfields and glaciers (white coal) which favour development of *water power*, (3) metallic ores for the manufacture of iron and steel and alloys, *e.g.*, ores of iron, manganese, chromium, nickel, tungsten, etc., (4) metallic ores required for military purposes (as in the manufacture of aeroplanes and shells), *e.g.*, Bauxite and ores of copper, zinc, magnesium, lead and tin, (5) gold, (6) refractory materials, such as magnesite, fireclay, bauxite, kyanite, sillimanite and zircon, (7) abrasives, such as corundum, (8) materials for manufacture of explosives, such as salt petre, toluene from coal tar and ammonia from coke ovens, (9) materials for chemical industries like salts, sulphur, pyrites and nitrates, (10) mica for insulation purposes in electrical instruments and wireless installations.

With the help of statistics showing quantity and value of mineral production in India for the five calendar years immediately preceding the present war. Sir Lewis Fermor in a paper appearing in the *Asiatic Review* (Oct. 1940) has discussed the position India occupies in respect to almost all these essential war minerals. Not only do we see India self-sufficient in important war minerals like coal, manganese, oil, mica, iron ore, chromite and bauxite, but she can also export substantial quantities of these important raw materials to Empire countries to meet essential needs.

Bauxite has received some special attention as metallic aluminium is becoming supremely important in modern warfare. Sir Lewis has discussed at length the position of bauxite and the possibilities of its development in India. India, it may be noted, is particularly rich in bauxite deposits of high quality. With cheap water power available in India, these ores could be profitably exploited for the extraction of aluminium.

Chromite.—Much information of value to the industrialist and economic geologist on chromite is to be found in a recent bulletin (*Rec. Geol. Surv. Ind.*, Bull. No. 2) issued by the Geological Survey of India. Students interested in the subject may also refer to the highly useful monograph on "Chromium ore and chromium" recently issued by the Imperial Institute which deals exhaustively with the nature, mode of occurrence and utilisation of chromite.

Chromite occurs in many parts of India, the commercially important deposits being those found in the Zhob District of Baluchistan, in the Mysore and Hassan Districts of Mysore and in the Singhbhum District of Bihar. In these places the mineral occurs mainly as a product of magmatic differentiation and is present as segregation masses, patches and veins in ultra-basic rocks. Its mining in India began in 1903 and up to 1940 a million metric tons valued at about a crore and half rupees was produced, all of it being exported. The Indian output for 1937 was 5 per cent. of the world output, and of the Indian total Mysore contributes about one-half and Baluchistan one-third.

This mineral is used for the manufacture of ferrochrome, metallic chromium for plating, chrome steels and chromium salts. It is also used as a refractory material in furnace linings.

It may be expected that in future the industrial utilisation in India itself of a good part of our output of chromite ore will be undertaken. The Mysore Government has already put up a plant for the manufacture of dichromates and the manufacture of ferrochrome may commence in the near future.

N. JAYARAMAN.

Studies in the Ascorbic Acid Content of Potatoes, Raw and Cooked.—Further studies on the change in the ascorbic acid content of potatoes taking place on cooking which throw light on some of the discordant results obtained by previous workers are reported as the result of work at the Nutrition Division, Department of Agriculture, U.S.A. (Lydia A. Rolfe, *Jour. Agr. Res.*, 61, No. 5). Incidentally, the ascorbic acid content in different varieties of potatoes in the different parts of potatoes and at different periods of storage are also reported. As the potatoes ripen there is a steady loss of ascorbic acid; Chippewa potatoes analysed semi-weekly for six weeks prior to maturity decreased in ascorbic acid content from 25·5 to 20·1 mg. per 100 grm. There is considerable loss of ascorbic acid in storage, ranging from 14 to 50 per cent. of the original content. The loss is more rapid in the early part of the storage period than later on. It was also found that potatoes in cold storage lost ascorbic acid rapidly. As regards the distribution of the ascorbic acid within the potatoes, it was found that the ascorbic acid content was higher towards the skin of the potato than in the interior and was likewise more at the bud end than at the stem end. Cooking did not alter this distribution. In new potatoes the variation in the ascorbic acid content from tuber to tuber was so great that losses obtained as the result of cooking could not be regarded as significant. Results with stored potatoes show that steaming and boiling unpared potatoes were the most conserving of vitamin C. Baking and pressure cooking caused slightly larger losses while boiling pared potatoes was the least conserving of the vitamin. The maximum loss of ascorbic acid due to cooking never exceeded 25 per cent.

A. K. Y.

Properties of Indian Coals.—The importance of obtaining a detailed knowledge of the physical and chemical constitution of coal with a view profitably to applying these results in its utilisation has been increasingly realised during recent years. The problem has of late engaged the attention of Indian scientists, and, of the various methods adopted to tackle it, extraction by solvents has yielded the best

results. This forms the subject of a paper published by the Geological Survey of India (as Professional Paper No. 10).

Investigations carried on into the action of certain solvents on two Indian Coals—one a caking coal from the Jharia field and the other a gas coal from the Raniganj field—reveal that the caking coal invariably yields higher amounts of extract than the gas coal, and the maximum amount of extract in either case is obtained by the action of Pyridine.

The caking coal is found to contain a less amount of solid bitumen than the gas coal but a higher content of oil-bitumen. For this reason it is very suitable for producing a good metallurgical coke which is of vital importance to the iron-steel industry. The individual constituents of the oil-bitumen and the solid-bitumen have been investigated and the results obtained reveal interesting facts regarding the constitution of coal. After extraction the residue of the caking coal possesses no caking propensities whatsoever.

Unburstable Container for Petrol and Water.—For dropping petrol and water supplies from aeroplanes, with or without the aid of parachutes, an unburstable container has been evolved by Sir S. S. Bhatnagar, Director of Scientific and Industrial Research. The container has been tested by dropping it from heights of 75 to 100 ft. and has satisfactorily withstood the impact of the fall.

The container is made of canvas *cum* plastic compositions, and as large as two-gallon containers have been made which have satisfactorily withstood the impact when thrown from the roofs of the second storey of the Alipore Test House and of the Secretariat Buildings, New Delhi. The Army Headquarters are making further experiments with the container by dropping it from low-flying aeroplanes.

This unburstable bottle has the necessary property of resilience and is petrol and oil proof. It is stated that, apart from its enormous advantage in war time, it can be used as a container for oil paints, oils, etc., even after the war. It is lighter and less liable to damage by impact than a tin can.

The Industrial Section of the Indian Museum, Calcutta, has acquired samples of fibres of commercial importance, *e.g.*, cotton varieties, jute, coir, palmyra, mesta, flax, aloe fibre, rhea or rhamæ, bow-string, sunn hemp varieties, etc. from different provinces of India, Burma and Ceylon. Cotton products are shown in different stages of manufacture from the raw materials to the finished cloth.

The Section has also acquired, for exhibition purposes, a large number of raw and finished silk products from almost all the principal silk producing centres of India.

Fibre Characters in Relation to Spinning Quality of Jute.—The investigations carried out at the Technological Research Laboratories of the Indian Central Jute Committee at Calcutta, on the relationship between fibre characters and spinning quality of jute, have shown that it is possible to predict the quality of the yarn that may be spun from any particular sample of fibre with fair accuracy on the basis of the fineness, strength and flexibility of the fibre. The results of the experiments conducted at the Laboratories, have been embodied in *Technological Research Memoir* No. 2. The practical importance of this work lies in several directions. Thus, since the spinning quality can be predicted from physical measurements made on the fibre, it will be possible to assess the quality of very small samples (say 2 lbs.); this is very important in connection with the work of breeding new strains of jute; it will give information as to what characters in the fibre make for good quality; it will also help in evolving a scientific system of grading the jute fibre.

Momordica Grosvenori is the name given by Dr. Walter T. Swingle to a new drug plant brought out of a remote part of China three years ago by a National Geographic Society Expedition (*vide Curr. Sci.*, 6, 256). A description of the new plant is published in the April number of the *Journal of the Arnold Arboretum* of the Harvard University. The name *Momordica Grosvenori* was given to the plant in honour of Dr. Gilbert Grosvenor, President of the National Geographic Society, who "for many years has encouraged liberally the geographic and botanical exploration of China".

The fruit of the plant, called "Lohan" by the Chinese, has long been used in the dried form in outer China as a house-hold remedy for colds, sore throats, minor stomach and intestinal troubles, and for other ailments. According to a press note issued by the *National Geographic Society*, an expedition of the Society under the leadership of Dr. George W. Groff, of Lingnan University, Canton, explored the mountain regions of northeast Kwangsi Province, in 1937, and found that the plant was a vine and its fruit gourdlike. The plant was identified by Dr. Swingle as a new species of Momordica.

Special importance is attached to Chinese drugs since the discovery, from the Chinese drug "ma huang" of the medicinal properties of ephedrin. This drug was unknown outside China 25 years ago.

Dairy Research in India.—A press note dated 6th May 1941, draws attention to the establishment of a Dairy Chemistry and Dairy Bacteriology Section of the Imperial Dairy Research Institute.

A reorganisation of the Imperial Dairy Department has been effected, and the Director of Dairy Research has taken over from the Imperial Dairy Expert the following duties: (*i*) advising the Agricultural and Veterinary Departments in Provinces and Indian States, and private persons who are engaged in the production and utilisation of milk; (*ii*) testing of dairy products for the public where such tests are of a special nature not normally falling within the duties of public analysts and other similar officials; and (*iii*) the prosecution of research work into problems connected with

the dairy industry, including handling and transport of milk and the utilisation of milk in the manufacture of milk products.

Enquiries on these matters should be addressed to the Director of Dairy Research, New Delhi. The Imperial Dairy Expert will in future be designated as the Dairy Husbandry Officer and Principal of the Imperial Dairy Institute, Bangalore.

Lady Tata Memorial Trust.—The Trustees of the Lady Tata Memorial Trust announce the Awards of the following Scholarships and Grants for the year 1941–42.

I. International Awards for research in diseases of the blood with special reference to Leucaemias:—(1) Prof. Eugene L. Opie and Dr. Jacob Furth, both of American nationality, Cornell University Medical College, New York. To continue the work in progress upon the Leucaemias like diseases of fowls and their relation to neoplasms, and to determine the nature of viruses producing leucaemias and associated neoplasms lymphomatosis, myelomatosis, endothelioma, Sarcomas, etc. (*Grant of* £400). (2) Dr. P. A. Gorer, Greys Hospital, London. To continue the studies in the genetics of mouse Leucaemia. (*Grant of* £70). (3) Dr. A. H. T. Robb-Smith, Nuffield Reader in Pathology and Morbid Anatomy, Oxford University. To continue the aid to the establishment of a "Lymphonode Registry" in the School of Pathology at Oxford to aim at better classification and follow up of human cases showing progressive hyperplasias and neoplasms of the lymphoreticular tissues including cases of the leucaemias, lymphadenoma, lympho sarcoma, etc. (*Grant of* £400). (4) Dr. Werner Jacobson, Part-time Sir Halley Stewart Fellowship at the Strangeways Research Laboratory, Cambridge. To continue the histo-chemical study of the argentaffine cells of the gut epithelium, with a view to determining whether they are the source of the intrinsic factor of castle, and hence their bearing on the problem of pernicious anemia and other blood diseases. (*Grant of* £250; *i.e.*, £200 part-time personal grant and £50 Research expenses).

II. Indian Scholarships of Rs. 150 per month for one year from 1st July 1941 for Scientific investigations having a bearing on the alleviation of human suffering:—(1) Mr. T. J. Job, B.A. (Madras), M.Sc. (Lucknow), to continue the work on the "Practical utility of insectivorous fishes in the biological control of mosquitoes." (2) Dr. Sachchidananda Bannerji, M.Sc. (Cal.), M.B. (Cal.) to continue investigations "On the comparative methods for determining the vitamin C status of the body and the role of vitamin C in infection". (3) Mr. G. B. Ramasarma, B.Sc. (Hons.), A.I.I.Sc., to continue research on "Vitamin A, specially provitamins and the role of fat in their absorption". (4) Mr. S. Rajagopalan, M.Sc. (Madras), to continue the work "On synthesis of new sulphanilamides". (5) Mr. P. Subraya Sarma, M.Sc. (Madras), to do research on "The influence of fats on the absorption of vitamin D and the cure of rickets". (6) Mr. Debabratha Das Gupta, M.Sc., to carry on "Research on chemotherapy of bacterial infections". (7) Mr. Nirmal Chandra Datta, M.Sc. (Dacca), to carry on "Investigations on certain aspects of role of fat in human nutrition".

Board of Scientific and Industrial Research.—Over fifty schemes of research were considered by the Board of Scientific and Industrial Research at their fifth meeting held in Simla on May 16, 1941, and of these twelve were recommended. Of the latter, mention may be made of the following:—

Manufacture of Carbon Electrodes for the Aluminium Industry, on which work is to be carried out at the Indian Institute of Science, Bangalore.

Application and standardisation of vegetable dyes from certain barks, to be carried out jointly by Mr. M. N. De at the Silk Institute at Bhagalpur and Dr. K. Venkataraman in the Department of Chemical Technology, University of Bombay.

Erection and operation of a pilot plant for the manufacture of butyl alcohol and acetone, by Dr. H. D. Sen and Dr. B. C. Guha at the Imperial Institute of Sugar Technology, Cawnpore.

Four schemes relating to synthetic dyestuffs were sanctioned. These are the preparation of vat colours, by Dr. K. Venkataraman; preparation of mono- and di-alkyl anilines, by Mr. B. C. Roy, University College of Science, Calcutta; investigation of electrolytic methods for the preparation of anilines, etc., by Dr. B. B. Dey, Presidency College, Madras; and manufacture of aniline from chlorobenzene, by Dr. G. P. Kane, Department of Chemical Technology, University of Bombay.

The Board also recommended schemes for the continuation of work on the manufacture of vaccum and compressor pumps by Prof. M. N. Saha, and for the manufacture of sodium cyanide, by Dr. J. C. Ghosh.

Glossary of Technical Terms used in Irrigation Practice.—A revised edition of the publication "Glossary of Technical and Vernacular Terms in Connection with Irrigation in India, together with Standard Notations", has been brought out by the Central Board of Irrigation.

The first edition was issued in 1934, but since that date many additional terms as well as definitions have been formulated.

This publication constitutes a standard reference on definitions of irrigation terms, some of which are extremely complex. Its effect will be to prevent the confusion caused by the employment within India of different terms for the same object.

Herd Books for Indian Cattle.—With a view to establish the cattle-breeding industry on a secure basis, the *Imperial Council of Agricultural Research* at its last November meeting, formulated rules and regulations for the establishment and maintenance of Central Herd Books.

The scheme is restricted in the first instance to Sahiwal, Sindhi, Hariana breeds of cattle and Murrah breed of buffaloes. Applications for registration of animals are invited from

persons who own or breed stocks of these four breeds. The milk yielding qualifications are respectively 3,000, 2,500, 2,000 lbs. for Sahiwal, Sindhi and Hariana cows and 3,000 lbs. for Murrah buffaloes in a lactation not exceeding 300 days in length. No fee will be charged for registration of pedigrees, performance, births or transfers. Necessary forms will be supplied free.

The Annual Report of the **Indian Association for the Cultivation of Science** for the year 1940, includes a brief resume of the work carried out in the Laboratory by Prof. K. S. Krishnan, F.R.S., and his associates. The work carried out here, particularly in the field of crystallographic studies with special reference to Magnetic, Electric, and Optical properties, are well known, and further significant contributions have been made during the year under report. Thus it is found that the conductivity of graphite in the basal plane compares favourably with that of many metals, whereas the conductivity along the perpendicular direction is extremely feeble, and is at least 10,000 times less than the conductivity in the basal plane. Magnetic studies on copper sulphate pentahydrate at low temperatures have also revealed that the copper atom in the crystal is not present as cupric ion but is covalently bound to the four water molecules that form a square around it, so as to give the complex $[Cu(H_2O)_4]++$.

Indian Statistical Institute.—The ninth Annual General Meeting of the Indian Statistical Institute was held on 24th April 1941, in the chamber of the President, Sir Badridas Goenka, who presided.

The meeting approved of the Honorary Secretary's proposal to bring out a popular supplement to the *Sankhya* with a view to presenting to the public an account of statistical investigations of a practical nature in non-technical language.

The Hon'ble Sir Girja Shanker Bajpai, Member-in-Charge of the Department of Education, Health and Lands, Government of India, was elected an Honorary Member of the Institute.

Sir Badridas Goenka was re-elected President of the Institute for 1941–42. Dr. S. C. Law was re-elected the Honorary Treasurer and Prof. P. C. Mahalanobis the Hon. Secretary. Prof. K. N. Chakravarti and Mr. K. R. Nair were elected Hon. Joint Secretaries.

MAGNETIC NOTES

April 1941.—Magnetic activity during the month was much less than that during the preceding month. There were 15 quiet days, 13 days of slight disturbance and 2 days of moderate disturbance as against 13 quiet days, 13 days of slight disturbance and 4 days of moderate disturbance during April 1940.

The most disturbed day during the month was the 24th when a magnetic storm of moderate intensity was recorded. The day of least disturbance was the 27th. Characters of individual days are shown in the following table:

Quiet days	Disturbed days		
	Slight	Moderate	Very great
1, 4, 5, 6, 8, 13, 14, 15, 17, 21, 22, 23, 27, 29, 30	2, 3, 7, 9, 10, 11, 12, 16, 18, 20, 25, 26, 28	19, 24	..

There was only one storm of moderate intensity during the month, the same number as in April last year. The mean character figure for the month is 0·57 as against 0·70 for the same period of last year.

P. P. JOSHI.

Colaba & Alibag Observatories.
Bombay.

ASTRONOMICAL NOTES

The Earth will be in aphelion on July 3.

Planets during July 1941.—Mercury, after inferior conjunction with the Sun on July 3 passes into the morning sky; it attains greatest elongation from the Sun (20° 0′ W.) on July 24, when it will be visible as a reddish star of magnitude 0·4, for more than an hour before sunrise. Venus continues to be an evening star and is gradually separating from the Sun; it will become a fairly bright object low down in the western sky just after sunset. Mars is rapidly moving eastward along the northern border of the constellation Cetus and is also increasing in brightness, it can be seen as a prominent star (of magnitude — 0·7), rising about an hour before midnight.

Both Jupiter and Saturn are in the morning sky and are getting away from the Sun. They will be situated about half way up in the eastern sky just before sunrise. The ring system of Saturn will be seen considerably more widened since last year, the angular dimensions of the major and minor axes being 38″·8 and 15″·6 respectively, on July 15. About three degrees to the northeast of Saturn is Uranus which is continuing its slow eastward march in the constellation Taurus.

The meteoric showers known as Delta Aquarids may be seen about the end of July. The average duration of the showers is three days and the date of maximum July 28. These meteors are observed to have slow long paths, and the approximate position of the radiant is given by R.A. $22^h\ 40^m$, Declination 17° south.

T. P. B.

SEISMOLOGICAL NOTES

May 1941.—During the month of May 1941, 1 feeble, 3 slight and 3 moderate earthquake shocks were recorded by the Colaba seismographs as against seven slight, four moderate and one great shocks recorded during the same month in 1940. Details for May 1941 are given in the following table:

Date	Intensity of the shock	Time of origin I. S. T.	Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
May 1941—		H. M.	(Miles)		(Miles)	
6	Slight	22 25	1450			
9	Moderate	11 03	3300			
14	Slight	12 38	1800			
16	Moderate	12 45	1790	Epc. : Near lat. 24°·5 N., long. 101°·0 E., in Yunnan Province, China		
17	Moderate	07 55	6730			
22	Slight	06 30	1450			
28	Feeble	23 16 (Time of first phase)	Local	Epc.: In the neighbourhood of the City of Bombay		Tremor. felt in Bombay City and Ratnagiri

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, No. 4584.
"Biochemical Journal," Vol. 35, Nos. 1–2.
"Agricultural Gazette of New South Wales," Vol. 52, Part 4.
"Biological Reviews," Vol. 16, No. 2.
"Journal of Chemical Physics," Vol. 9, No. 4.
"Indian Forester," Vol. 67, No. 6.
"Transactions of the Faraday Society," Vol. 37, Pt. 4.
"Indian Farming," Vol. 2, No. 5.
"Geological, Mining and Metallurgical Society of India" (Quarterly Journal), Vol. 12, No. 4.
"Bulletin of the American Meteorological Society," Vol. 22, No. 2.
"Indian Medical Gazette," Vol. 76, No. 5.
"Journal of Nutrition," Vol. 21, No. 4.
"Journal of the Bombay Natural History Society," Vol. 42, No. 2.
"Nature," Vol. 147, No. 3726.
"Journal of Research," National Bureau of Standards, Vol. 26, No. 3.
"Science and Culture," Vol. 6, No. 12.
"Indian Trade Journal," Vol. 140, Nos. 1821–22 and 1824.

Books

"An Introduction to Kant's Critique of Pure Reason," by N. A. Nikam. (The Bangalore Press), 1941. Pp. 196. Price Rs. 5–8–0.
"Principles and Practice of Chromatography," by A. L. Bacharach and F. A. Robinson. (Chapman & Hall, London), 1941. Pp. 362. Price 25*sh.*
"Spectrochemical Abstracts," Vol. II, by Ernest G. S. Van Someren. (Adam Hilger, London), 1941. Pp. 39.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

May 1941, SECTION A.—V. T. CHIPLONKAR: *Rectification in discharge tubes. Part II.* N. S. NAGENDRA NATH AND E. V. CHALAM: *The intensities of the Raman lines in carbon dioxide.* The polarisability of a molecule is assumed to be made up of the bond polarisabilities as functions of the inter-nuclear distances. The idea is applied to CO_2 and the intensity ratio of the Fermi split lines has been calculated. The results are in good accord with experimental observations. C. V. DELIWALA AND N. M. SHAH: *Aluminium chloride, a new reagent for the condensation of ketonic esters with phenols. Part V. The condensation of substituted resacetophenones with ethyl acetoacetate.* S. S. DHARMATTI: *Magnetism and molecular structure of sulphur compounds.* The magnetic method is of great value in fixing the correct molecular constitution and the magnetic susceptibilities calculated by Slater's and Angus's method are in better agreement with the experimental ones. (LATE) N. W. HIRVE, MISS K. D. GAVANKAR AND B. V. PATIL: *Studies in chloral amides. Part X. Reactivity of α-Halogen in α-Halogeno chloral-methoxy nitro-, and bromo-benzamides.* L. A. RAMDAS AND S. Y. JOGLEKAR: *Studies of thermal repulsion*: The thermal pressure is about 1000 times as large as radiation pressure. A thermal filter and a dust counter utilising the above phenomenon have been designed. K. GANAPATHI: *Chemotherapy of bacterial infections. Part IV. Synthesis of (N^1)-sulphonamide substituted heterocyclic derivatives of sulphanilamide.* In an attempt to assess the anti-bacterial effect of sulphanilamides with various heterocyclic rings

introduced into the (N^1)-sulphonamide radical, typical derivatives of guanidine, thiodiazole, uracil, barbituric and pyrimidine have been synthesised. B. R. SETH: *On the gravest mode of some vibrating systems.* P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *The glycosidic components of the flowers of* Butea frondosa. P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *A study of the chemical components of roots of* Decalepis Hamiltonii. *Part III. Comparison with* Hemidesmus indicus (*Indian Sarsaparilla*). T. R. SESHADRI AND V. VENKATESWARLU: *Synthetic experiments in the benzo-pyrone series. Part IV. Synthesis of karanjin.* S. RAMACHANDRA RAO AND K. S. SANKARASUBBA IYER: *Photoelectric efficiency of ferromagnetic metals at different temperatures in the soft X-ray region.* Experiments were carried out at different temperatures, ranging from 30° C. to 950° C. The photoelectric sensitivity of iron is lowered by 10 per cent. in the range 780° to 900° C., while for cobalt and nickel it is constant. The photoelectric effect due to soft X-rays is similar more to the effect with ultra-violet light than to the effect produced by hard X-rays. K. SUNANDA BAI: *Depolarisation of light scattered by liquids.* In the case of 18 liquids, the graph of half slit width (range 2000μ to 10μ) as abscissæ and observed depolarisation as ordinate, is nearly horizontal up to about 10 cm.$^{-1}$, below which it falls off rapidly. The wings in liquids start with maximum intensity at the Rayleigh line and fall off exponentially with increasing wave number shift. P. I. ITTYERAH AND KANTILAL C. PANDYA: *Condensation of malonanilic acid with aldehydes. Part IV. With* o-, m- *and* p-*methoxybenzaldehydes: The influence of a hydroxy-group.*

SECTION B.—RUSTOM JAL VAKIL: *An analysis of normal electrocardiograms.* BENI CHARAN MAHENDRA: *Contributions to the bionomics, anatomy, reproduction and development of the Indian house-gecko,* Hemidactylus flaviviridis *Rüppel. Part II. The problem on locomotion.* SHRI RANJAN AND SANTOSH KUMAR BASU: *Physiological studies on the wheat plant —V. Diurnal variations of total nitrogen and amino-acid nitrogen in* Triticum vulgare. T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Contributions to the morphology and cytology of* Alpina calcarata *Rosc., with special reference to the theory of zingiberous flowering.*

Indian Chemical Society: (*Journal*)

March 1941.—D. R. KULKARNI, R. L. ALIMCHANDANI AND N. M. SHAH: *The condensation of α-substituted acetoacetates with phenols. Part III. The Pechmann condensation of ethyl α-(α-hydroxy-βββ-trichloroethyl)-acetoacetate.* DEBABRATA DAS-GUPTA AND TEJENDRA NATH GHOSH: *Quinoline derivatives. Part VI.* D. R. KULKARNI, R. L. ALIMCHANDANI AND N. M. SHAH: *The condenasation of α-substituted acetoacetates with phenols. Part IV. The condensation of cresols and other less reactive phenols with ethyl α-(α-hydroxy-βββ-trichloroethyl)-acetoacetate.* G. GOPALARAO AND K. S. MURTHY: *Photosensitisation by solids. Part II. Photosensitised oxidation of ammonia in aqueous solution with titania as the photosensitiser.* SHRIDHAR SARVOTTAM JOSHI AND A. PURUSHOTTAM: *Coagulation of colloids by exposure to high frequency oscillations.* K. V. GIRI: *The influence of vitamin C on the inactivation of enzymes by ultra-violet light.* PANCHANAN NEOGI AND KANAI LAL MANDAL: *Co-ordinated mercury compounds with ethylene and propylenediamines.* PRIYADARANJAN RAY AND JAMINIBHUSHAN ROY-CHOWDHURY: *Biguanide sulphate as a reagent for the estimation of copper.* S. S. GUHA-SIRCAR AND SASANKA CHANDRA BHATTACHARJEE: *The use of nitroso derivatives as reagents in inorganic analysis. Part I.* S. S. GUHA-SIRCAR AND SASANKA CHANDRA BHATTACHARJEE: *The use of nitroso derivatives as reagents in inorganic analysis. Part II.* YEO SEIN GWAN: *A new method of preparation of aceto- and benzonitriles.* M. B. ROY: *A new colorimetric method for the chlorate ion.* U. P. BASU AND S. J. DAS-GUPTA: *A note on certain heterocyclic sulphonamides.*

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UNIVERSITY FOR ORISSA

IN determining the type of university most suitable for Orissa, the University Committee appointed by the Congress Ministry in 1938 has reached the decision that a wholly centralised variety would not accord with the actual requirements of the Province, and would not be justified either by the distribution of the collegiate institutions in the State or by the stage of educational development now attained. Presumably after carefully investigating the wealth of experience accumulated in many places and in many directions, the Committee have favoured the establishment of an affiliating university at Cuttack, and it must be remembered that there is already a similar university functioning at Patna. Since the older Universities of Calcutta, Madras and Bombay still retain the garb though not the clothes of a mere examining body, it may be reasonable to suppose that the judgment of the Orissa Committee is wise, especially in view of the circumstances prevailing in the Province. The jurisdiction over which the new university will exercise its control is fairly limited,—an advantage which will promote its efficiency. Further it may not be absolutely a correct policy to break with the past.

It is true that under the stimulus of the Universities Act of 1904 and under the influence of public opinion people have come to regard that a university should share in the actual work of teaching, instead of

remaining an impassive body controlling higher education through public examinations. Not until the impact of popular demand became irresistible, did the universities established in 1857 readjust their constitutional machinery. The various reports of University Commissions have emphasised and approved the popular feeling that the universities must be invested with the responsibility of co-ordinating their functions with the social, physical and intellectual needs of their students, and with the economic and industrial activities of the State. The recent university projects inaugurated in the last few years accentuate and reflect this higher conception of the functions of a university.

We have not the full report before us. It would be premature to discuss the merits of the Orissa Committee's recommendations from the meagre extracts that have been published. Judging by their look, the proposed university will acquire the structural and functional pattern enjoyed by Madras till 1908, without, however, its congestion and extensive academic jurisdiction. These features may at first sight seem uninviting, but there can be little doubt that the recommendations of the Committee might contemplate an ultimate design by which it will gradually be possessed of possibilities transcending the scope of the original intentions. Even among the teaching universities there is not uniformity of pattern, for there are those which are strictly unitary in type in which all teaching of a formal nature is conducted by the university organization, and there is the second variety which fulfils its functions through the constituent colleges associated with it. India is sufficiently diverse to provide ample room for universities of all complexions, and her requirements can be met by the unitary universities as well as by the affiliating universities.

Among the various causes which have militated against the fruitful development of the unitary universities or against any other type in maintaining a high standard of moral and intellectual endeavour within their jurisdiction, or in acting as clearing houses of knowledge promoting the material prosperity of the country, the greatest are lack of endowments and adequate subvention on the one hand and superfluity of student population on the other. The boundary line separating the different categories of universities must be, after all, in the long run, a matter of constitutional expediency, and need not necessarily be the means of such profound significance as to alter the fate and fortune of a whole country. What India wants is a network of inspiring seminaries of knowledge, within whose halls there are men who are little universities in themselves, and whose creative genius will fertilise the minds of young men, who in their turn will blossom into dynamic intellectual apostles. Sir Venkataraman placed in Sahara, Bow Bazaar or in the Indian Institute of Science is a smiling university in himself. It is obvious that, since mankind has not yet invented a process of making bricks without straw, the Indian universities suffering from chronic financial anæmia cannot be accused of lagging behind their foreign congeners, which can very well stand a considerable amount of transfusion. Nevertheless it must be gratefully acknowledged that the Indian universities struggling under severe handicap have produced work which is at

once impressive and significant. Orissa need not be troubled over the type. If it has ample financial support and potential men such as Sir Venkataraman, Professor Saha, Dr. Ghosh, Professor Sahni, Professor Krishnan and Sir Radhakrishnan, the proposed affiliating university will achieve distinction.

Even more serious than financial inadequacy is the unmanageable size of student population,—a condition hostile to the successful evolution of a corporate intellectual communion in the universities, comparable to the best traditions of the older British universities. All attempts in the direction of imposing restraints on the free admission of students must be deprecated. The greatest reproach of our universities is that they act as a sort of one-way traffic system, leading the students ultimately into blind alleys, instead of being centres of divergent radiation, along which young men could march in a spirit of hope and courage to places where they might fulfil their destiny. All the existing universities have a handsome but unexpressive face; viewed from any standpoint, their duplication is indefensible. We could put the available resources to a better purpose and might even hope of attracting more funds, if we plan a brotherhood of regional universities, having affiliations to each other, intimately related to the larger human problems, specialising in some departments of knowledge with provision for schools of research, instead of ambitious crowded schemes leading to duplication and wasteful effort. There is rather a great need for realigning our universities not on a constitutional but a federal basis, each constituent university having autonomous control, directing its specialised department or departments,—humanities; pure and applied branches of science; social, political and economic science; professional colleges; technology; administration; transport, communication, commerce and statistics; finance and related institutions. Besides securing relief from congestion, the federal scheme will provide sufficient room for students belonging to communities with different occupations, aptitudes and outlook, and the present tendency to regard the passage of all university students through the same curricula of studies, which has become a normal practice, should give place to diversified courses concentrated in different specialised centres. It is not equitable that young men should be denied all facilities for education of the university standard, merely because they have no aptitude for the cast iron uniformity of studies.

The reconstruction of our universities for direct use to the society is a duty as instant as that of improving natural knowledge for discovery. They are not to be regarded merely as a channel of escape to a world of discontented young men, and should not seek vindication on remote and abstract criteria. A university is at bottom a social function, with inescapable social responsibilities and obligations, and if our universities are to live as a vital force, they must ever keep human values and problems in the forefront, and they must justify their existence by their contributions to the enrichment of the spiritual and material wealth of the nation.

SILVER JUBILEE CONVOCATION

THE UNIVERSITY OF MYSORE has just celebrated its Silver Jubilee to denote the completion of its twenty-five years of proud and fruitful existence. The history of this young and vigorous University is a noble record of solid achievements in every field of endeavour for which it has made ample provision. The expectations which were formed by its founders have been generously fulfilled and the University holds promise of future developments which will create for it the highest cultural traditions and the power of leadership which we associate with the best colleges of foreign universities. A large and distinguished gathering of representatives of other universities attended the Celebration and felicitated the authorities. The history of the administration of the Mysore University during the last quarter of a century falls into four definite periods of development, each co-ordinated with the other on the basis of a continuous policy of organisation and progressive consolidation. The first Vice-Chancellor, Mr. H. V. Nanjundiah, has had to deal with the constitutional machinery and to bring it into working order, and on the completion of his labours, he was succeeded by Sir Brajendra Nath Seal. During his period of office the University was pulled inside out and reassembled by initiating a series of reforms in the structure and functions of the University. When Dr. E. P. Metcalfe assumed charge, his duties consisted in guiding the even tenor of the University activities resulting from the academic reforms instituted by the previous administration. We may call this the flowering period. Mr. N. S. Subba Rao, who is now controlling and directing the destiny of the University, has, while conserving his inheritance, given a new orientation to the purpose and interpretation of University life. This is the fruiting season, promising richer and perennial crops.

A Special Convocation was held, which was addressed by the Chancellor, His Highness Sri Jayachamaraja Wadiyar Bahadur, who is a distinguished alumnus of the University. The refreshing feature of this address is its freedom from platitudes which form the staple of public utterances. It breathes a new spirit in consonance with the rapid changes in the social and economic spheres of national and international life and gives a new message which transcends local interests. "The Government look to the University not only to supply them with public servants, but to assist the State in its manufacturing concerns by co-operating in research and development work; and still more important, to play its part in the democratisation of knowledge and in closing the gap between the educated and the uneducated." In all these activities the University has shown a commendable zeal, and in the voluntary organization known as University Teachers' Association, it has found an able and willing ally in the dissemination of knowledge. This institution for which India furnishes no parallel, organizes lectures with demonstrations on scientific and humanistic subjects in the language of the country in all centres and study classes among illiterate people in the rural areas. In all these efforts, the students, who have also organized themselves into small groups, render invaluable help, and what is most praiseworthy is that women-teachers and women-students take a prominent part in educating adult women and young girls in the villages. These visits are not spasmodic, but form an integral part of a carefully planned literary campaign, so that lapses are not permitted to occur. Genarally at all these lectures and class studies, the Vice-Chancellor is present whose patriotic zeal and inspiring guidance must afford a stimulus to the honorary workers on the one hand and fill the hearts of the simple country people with feelings of joy and gratitude on the other. In this as in other organizations like "University Settlement", "The Social Welfare Committee", "The Adult Literacy Association", "The Music Club", "The University Unions", Mysore University is almost the solitary instance in India, daring to take the university life to the doors of the people. A university that contents itself with producing a few brilliant stars in an otherwise dark firmament has few claims upon the people; it must vindicate its existence by the amount of service it renders to the country. If this is the criterion of judgment, then Mysore has a proud record. We have pleasure in associating ourselves with the rest of India in offering the University our felicitations and in expressing our hopes that the dark corners of human existence in the State will soon radiate "sweetness and light".

RESEARCH WORKERS AND THE PATENT SYSTEM*

I. SHOULD INVENTIONS BE PATENTED?

BY

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(*Examiner of Patents, The Patent Office, Calcutta*)

THE first question which arises before the mind of a person who has made an invention is whether it is desirable for him to protect it by means of a patent. Presuming that the inventor can take out a patent for his invention, this question can be considered either from the standpoint of an inventor who from purely altruistic motives wants to make his invention freely available to the public so that they may enjoy its full benefits, or from the point of view of an inventor who has the motive of enjoying as many of the benefits of his invention as possible. To decide whether it will be worth the inventor's while to take out a patent in order to achieve either of the two above-mentioned objects, a thorough estimate of the assets and liabilities which will accrue to the inventor by taking out a patent for his invention must be made.

Before trying to analyse what will be on the credit and the debit sides if a person takes out a patent, it will not be out of place here to refer to a few misconceptions about the patent system, which are prevalent in the minds of many people.

There is a class of people who seem to think that a patent is akin to a certificate of merit whereby the utility claimed for the inventions is endorsed by the Government. This is not so. By the grant of the Patent rights, the Patent Office does not in any way vouch for all that is expounded or claimed by the patentee.

Another misconception is, that by possessing a patent a person would be able to manufacture an article by a slight alteration of a manufactured article based on an existing patent, so that the new article produced embodies all the essential features of the old one in addition to slight variations in non-essential details. This also is not true, as a later patent can in no circumstances prejudice the rights of an earlier patentee.

* The views contained in this article reflect the views of the author only and do not represent those of the Government and should not be taken as committing the Government in any way.

Now, a patent is a privilege or a right conferred by the Government by which the patentee can enjoy the exclusive right of working the patented invention, or authorising others to do so, as long as the patent right is in force. This right, however, is conferred on him subject to the condition that he makes a complete disclosure of his invention so that after the termination of the patent, the public would be able to make a free use of his invention. Other conditions which are imposed on him are, that he would not exercise his patent injuriously to the public, or in restraint of trade, or for illegal or immoral purposes, and that he would continue to pay an annual fee to keep the patent in force for the period for which the patent has been granted.

Coming back now to the main question, let us examine how the object of the philanthropic inventor would be achieved with regard to his intention of making over his invention for the free use of the public as early as possible. Such a person has two alternatives before him. He can either protect his invention and then make over the rights of using it to any one free of charge, or else, he can just leave it open to anyone who cares to make use of it. Some people, however, feel that if a patent is taken out for an invention,—the benefits of the invention are only enjoyed by the patentee. These people, in thinking so, overlook a number of relevant factors which play an important rôle in ensuring the availability of a useful invention for the public use. These factors are considered below.

First, in order that the public may become aware of his invention, information about it should be accessible to the public at a place where they would normally look for it. The Patent Offices are universally regarded as the repositories of all the ideas and suggestions put forward from time to time by inventors about various industries; and therefore, the Patent Office records are the most natural sources where the public would look for new ideas to improve their industries. It follows therefore that an

inventor who does not patent his invention, does not make use of the Patent Office records and thus foregoes the facilities provided by the most important agency through which the publicity of his invention amongst those who are likely to be interested in it, can be ensured.

The second factor which is generally overlooked, is the full appreciation of the fact that considerable expense has to be incurred by the manufacturer to develop an invention to such a degree of perfection that when the public come to know of it they should like it; and in order that they may also adopt it for practical use, he should make the article available to the public at an attractive price by manufacturing it by mass production. This also will involve a considerable outlay of capital because numerous experiments will have to be made during the development of the invention into a finished article. In the ordinary course of events, there is very little likelihood of anybody coming forward to undertake the trouble or to risk his capital for these purposes, unless he can reasonably hope to recover all the initial expenses incurred and subsequently to enjoy a fair margin of profit as a return for the financial risk and trouble he has taken.

To drive this point further home, the examples of Herbert Spencer's[1] easy-chair and Laval's[2] cream separator are given here. Herbert Spencer once invented an excellent invalid chair and wanting to give it to the world without any recompense, did not patent it. The result was exactly contrary to what he aimed at. No manufacturer dared to undertake its manufacture. Each thought to himself that if he succeeded, competitors would spring up and rob him of most or all of his profits, while there was always present the risk that he might fail.

The case of Laval's cream separator is equally illustrative. Many years ago, Laval designed a hand-worked cream separator for use in the household. In the interest of the world—as he mistakenly thought then—he threw his design open to any one who desired to make use of it. But no one did so, and instead of a plentiful supply of the cream separators at low prices, none were manufactured because no one would obtain a monopoly for their manufacture.

[1] *Economics of Our Patent System*, by Vaughan, p. 30.
[2] *The Engineer*, **156**, No. 4056, p. 335.

The third consideration is that even if a person does not take out a patent, he cannot prevent others from patenting the same invention and thereby deprive the public and himself from enjoying the benefits of his invention.

Then there is another danger in not taking out a patent. All the inventions are not usually published in scientific journals and those which are published may not embody in the publications all the essential features of the invention. This leaves a loophole for the man who imitates the invention in all the essential details and in his patent application puts forward a claim or claims which have not been clearly implied in the publications of the original inventor. The result is, that the imitator can get away with some one else's invention, as under the circumstances, the real inventor may not be able to oppose the patent successfully on the grounds of any valid anticipation. In cases where the original inventor has not taken out a patent for his invention but some one else has, the inventor, even if he is in a position to prove ultimately that he had made the invention available to the public before his rival appeared on the scene, will have to undergo no end of trouble and expense to prove that he was a prior inventor, that he had given publicity to the invention, or that he had used the invention to such an extent as to bar the subsequent grant of a valid patent for it. Moreover, in such contested cases, the expenses incurred in proving the invalidity of such patents, run into thousands or tens of thousands of rupees. On the other hand, if the inventor adopts the ordinary expedient of taking out a patent for his invention as soon as it is made, then it would cost him almost nothing to establish either his priority of invention or the non-patentability of the invention by his rival. Therefore, in the interest of the public as well as in his own interest, it is advisable for an altruistic inventor to take out a patent for his invention before it is too late.

It is a fact that there is always an innate prejudice against new ideas and especially new ideas when they happen to be in the technical field. Even an invention possessing great merit and advantages cannot, therefore, earn a good name unless the manufacture of spurious and inferior goods is as far as possible eliminated. To do this effectively, it must be possible for the

inventor to control the production of new articles in their early stages of manufacture, in a pure and standardised form. How this sort of control can be exercised by means of the Patent system is very well illustrated in the case of the manufacture of 'Insulin' which was patented as soon as it was invented. The inventors then issued licences only to competent and reliable manufacturers, and the result of this control was that 'insulin' was manufactured in the standardised form only, so that medical practitioners could appreciate its good properties and 'insulin' became known as a very reliable drug. It is a moot point, however, whether the good effects of 'insulin' would have been appreciated as promptly as they have been, if the control in its manufacture, which was exercised by the patentees before it gained in popularity, had not been so exercised.

The above analysis of the question therefore shows that even from the point of view of the altruistic inventor, his object would be better served by patenting his invention rather than throwing it open to the public without any protection.

Next the question of the Research Worker and the Patent System will be considered from the standpoint of the inventor who wants to enjoy for himself all the possible benefits likely to accrue from his inventions. There are two ways by which he can do so. One is by keeping his invention an absolute secret while exploiting it, and the other is by patenting it. For the latter, the inventor will have to disclose it fully and the monopoly rights will be in force for a limited period only.

Let us take first of all the case of the man who wants to rely on secrecy as the preferred form of ensuring personal profits. A large number of inventions by their very nature are inherently incapable of being protected by secrecy. In the case of machinery, for example, the moment it is put in the market, it is subjected to the minutest scrutiny by the public with the result that secrets cannot exist as regards machine construction. Even in the case of "process" inventions which theoretically can be kept secret, a person who relies on secrecy relies on a thoroughly undependable method, for secrets are notorious for their tendency to leak out. Whatever precautions an inventor may take to maintain the secrets of his invention, there comes a time, and invariably this happens too soon, when his secrets leak out. An interesting case occurred a few years ago when an inventor found out at great expense the secret process of spraying glass with a certain chemical compound so that the sprayed glass presented a golden lustre. The inventor left nothing to chance in order that his secret may not leak out. When chemicals arrived in sealed carboys, he removed the labels on them and substituted instead new ones with wrong names, so as to hide the identity of the chemicals. He used to mix the spraying mixture in the sealed sprayers with his own hands. Thus whatever was physically possible to keep his secrets, he did. But when a rival firm came to know of the bangles with golden lustre, they sent a few of their very clever men in the guise of workmen to the factory to find out the secret process. These disguised men got employment in the factory, and during the spraying operation, they sprayed a little quantity of the chemical on their shirt sleeves. On going home, they got the sprayed chemical analysed and thus the secret was out. An idea of the extent to which the inventor suffered monetary loss can be gauged from the fact that before the secret leaked out, lustre bangles used to sell for Re. 1 a pair and after the leakage of the secret similar bangles were available for as little as an anna a pair! At this point the reader may say that as the bangles became cheaper it was all for the good of the people. It is pointed out therefore that this person had to spend thousands for securing this secret process from abroad and by failing to get a patent for his invention at the proper time he became a ruined man. One can only speculate how many other industries suffer the same fate when the inventors do not protect them by means of patents.

Let us now examine how an inventor who decides to take out a patent for his invention benefits himself under the Patent System. As already pointed out, a patent gives an inventor the right whereby he can enjoy the exclusive privilege of working his invention. Hence, with a patent for an invention in his possession, even the most impecunious inventor can approach a financier on terms of equality and arrive at a satisfactory financial agreement with him with regard to the exploitation of his invention. The prospect of a monopoly will also induce the financier to undertake the exploitation of the invention. Hence there is no danger

of any useful inventions going waste or of their being exploited by others without an adequate and equitable reward. This will facilitate the progress of negotiations between inventors and manufacturers for the purpose of commercially developing the inventions to their mutual benefit.

So far we have dealt with the subject of Patent System in relation to the research worker and have shown, that viewed at from all points of view, the Patent System provides the best form of securing the objectives of an inventor irrespective of whether he is actuated by altruistic motives or by motives of self interest. This is of course subject to the provision that proper steps and precautions are taken to secure a valid patent. What these steps and precautions are will be discussed in subsequent parts of the article.

ON THE MALABAR CYCLONE OF MAY 1941

BY

C. RAMASWAMY

(Meteorological Office, Poona)

RARELY do the cyclonic storms coming direct from the sea strike the Malabar coast. Since 1845, there have been only three storms which have developed in the Arabian Sea and hit Malabar. A few others, however, after forming in the Bay of Bengal have moved westwards across Malabar into the Arabian Sea. The storms of the first type cause more destruction in the coastal districts than the others, as they come straight from the sea without losing any of their energy in crossing the Ghats. The cyclone which struck Malabar on the 26th May 1941, belonged to the first type. A brief history of its development and movement is given below:—

On the morning of the 22nd May, the upper winds over Minicoy were blowing at 25–35 m.p.h. from the westsouthwest up to 2·0 km. and Colombo reported rough seas and 6″ of rain. These observations suggested that the southwest monsoon was advancing in the southeast Arabian Sea. The monsoon continued its progress during the course of the day and burst on the Malabar coast by the next morning; Trivandrum reported 10″, Cochin 7″ and Calicut 5″ of rain on the morning of the 23rd. Pressure started falling along the Malabar coast from the 23rd, the fall being greatest near Trivandrum on the 24th. On the morning of the 25th, an area of negative pressure departures appeared off the Malabar coast. The upper winds over Minicoy were blowing this morning from the west with gale force at least up to 1 km. while those over Mangalore, which on the previous day were blowing at 15–20 m.p.h. from the south or southwest, had strengthened to 20–30 m.p.h. and backed to south or southeast at all levels up to 4 km. These observations indicated that a depression had formed in the southeast Arabian Sea with centre near Amini Devi. By 17 hours of the 25th, the upper winds over Minicoy and Mangalore strengthened further and the seas along the Malabar coast became rough, pointing to an intensification of the depression into a cyclonic storm. Till 15 hours of the 26th, the cyclonic storm remained practically stationary with centre near Amini Devi. Then it began to move eastwards and was centred close to the coast south of Calicut at 22 hours I.S.T. It struck the coast about 30 miles to the south of Calicut (near Ponnani) just before midnight. Calicut recorded a pressure deficiency of about 0·27″ when the cyclone crossed the coast. The barometric depth at the centre of the storm might have been about 0·50″. After

entering land, the storm weakened rapidly and finally blew itself out in the Palghat gap by the next morning.

The weather charts showing the positions of the storm at 17 hours and 22 hours on the 26th are reproduced in Figs. 1 and 2.

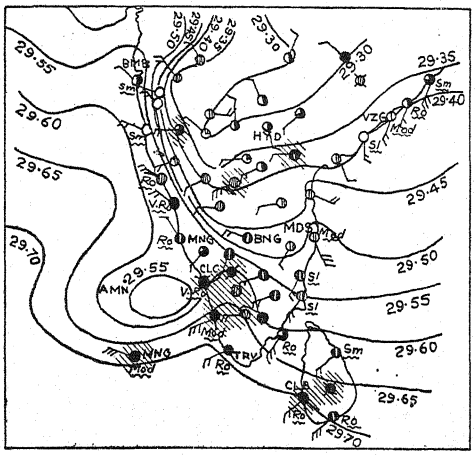

FIG. 1
26th May 1941 at 17 hrs. I.S.T.

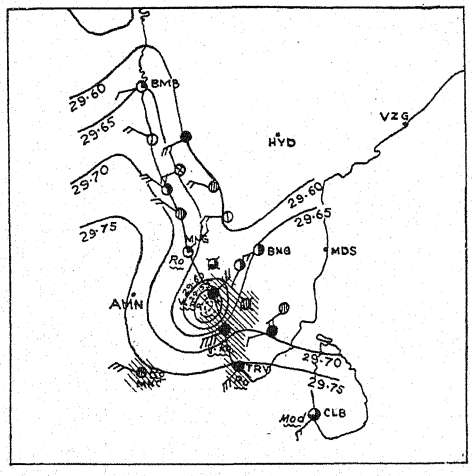

FIG. 2
26th May 1941 at 22 hrs. I.S.T.

Three feathers to the wind arrows mean a wind speed of 22–27 m.p.h. and four feathers 34–40 m.p.h. The hatched areas represent regions where rain was falling at the time of observation.

The following extracts from the Weather Diary of the Cochin Observatory which lay in the monsoon sector of the cyclone will be of interest:—

"By 7-30 p.m. (26th) the wind began to increase in violence and was coming in great gusts from WNW (6 Beaufort scale) each gust increasing in force to a storm" ..... "By 10 p.m. the wind had again shifted to WSW (30–40 m.p.h.) still increasing in violence" .....

"The storm continued to increase in violence after 00·00 hours." ..... "The average speed of the wind from 00·00 hour to 12 hours when the storm was at its severest was 48 m.p.h. and the speed of the gust at their highest is *estimated* to be about 80 m.p.h." .....

The cyclone was responsible for widespread and locally heavy rain along and near the Malabar coast on the 26th and 27th. Some of the noteworthy falls were Quilon 5", Calicut and Ankamally (Perambavoor, Travancore) 6" each, Mannar (Travancore) 8" on the 26th and Vadakhancheri (Cochin) 10" on the 26th and another 12" on the 27th.

According to press reports, the cyclone caused terrible havoc along the Malabar coast, particularly in the district of Malabar. In addition to the loss of about one hundred lives, a large number of persons are reported to have been seriously injured. The damage to property was also large. In the coastal areas, thousands of houses and huts and a number of bridges and culverts collapsed and several villages were swept away. The Taluk of Ponnani in the Malabar District suffered most in this respect. The agriculturists are reported to have suffered heavy losses by the destruction of their gardens and growing crops. In a few places, landslides also occurred burying valuable arable lands.

The storm was of small extent. Even when it was only about 40 miles from Calicut the strongest surface winds along the coast blew at 30–40 m.p.h. in gusts. The area where the winds reached a speed of 40 m.p.h. and more was probably confined to a radius of about 40 miles.

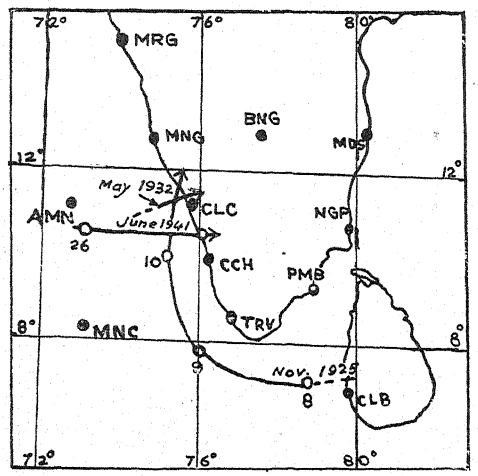

FIG. 3

Tracks of Malabar Storms.

In the absence of information about weather from ships, it is difficult to say when the storm developed the core of hurricane winds around its centre. The microseisms recorded at the Bombay Observatory however seem to show that the storm became severe after it started moving towards the coast.

The tracks of the cyclones that have struck the Malabar coast since 1845 are shown in Fig. 3. It will be seen that the recent cyclone followed an easterly course before striking the coast. This was very unusual, as the storms which originate in the south-east Arabian Sea generally travel in a northerly direction. Indeed, there has been only one other instance of a storm taking an easterly course in the southeast Arabian Sea—that of May 1932, shown in Fig. 3. It is interesting to note that, even the recent cyclone, in the earlier stages, tended to move towards the north. But, in the end, it decided to move eastwards and release all its energy in Malabar; and it did—with what disaster!

RAI BAHADUR PROF. K. C. MEHTA, Sc.D.

WE have great pleasure in congratulating Professor K. C. Mehta, Rai Bahadur, M.Sc., Ph.D. (Cantab.), F.N.I., of Agra College, Agra, on the award of the Sc.D. Degree of the University of Cambridge. It is a rare distinction and is a just recognition of the valuable contributions made by the Professor to our knowledge of the wheat rust problem of India. Notwithstanding heavy duties at the College, he has been conducting, since the year 1923, research on the various aspects of an obscure problem of great national importance, at considerable personal expense in the earlier stages of this work. Since 1930, these investigations have been continued with adequate grants from the Imperial Council of Agricultural Research and with the help of temporary research staff. After a comprehensive study of the parasites concerned, Prof. Mehta has been able to suggest simple and inexpensive methods of control of rust epidemics on wheat and barley. Prof. Mehta presided over the Botany Section of the Indian Science Congress in 1929.

LETTERS TO THE EDITOR

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POLARISATION OF SOME SPECTRAL LINES EXCITED BY LOW SPEED ELECTRONS IN A DISCHARGE TUBE CONTAINING MERCURY OR MERCURY-CADMIUM AMALGAM AS ANODE

IT is well known that the yellow lines of mercury excited by slow electrons in a discharge tube show strong polarisation, with their electric vector in the direction of the electron beam. The author has studied the problem with special regard to their depolarisation, when mixed with cadmium atoms, and also when a weak transverse magnetic field is applied to the source. The electron beam produced by heating a Tungsten filament was shot vertically downwards on a surface of mercury or mercury-cadmium amalgam (2 per cent. Cd) used as anode. Light going out from one of the sides was allowed to fall on the upper half of the slit of a Hilger Constant Deviation Spectrometer, after it has passed through a Nicol, which could be rotated so as to transmit light with the electric vector either vertical (let the intensity of this beam be I_1) or horizontal (intensity of this beam is I_2). For matching the intensity of the spectral lines the spectrum of a continuum as emitted by a Tungsten filament lamp was passed through the lower half of the slit of the spectrometer, the width of which could be varied by means of a calibrated screwhead. The whole arrangement thus acted as a polarisation spectrophotometer. By winding several turns of nichrome wire and passing current through it the tube could be maintained at a temperature of about 130° C. The heating current was cut off while taking observations so as to eliminate the effect of longitudinal magnetic field. The effect of the latter was however found to be very small and not more than 5 per cent. of the effect produced by a corresponding transverse magnetic field. The latter field was produced by placing near the tube a flat coil containing a large number of turns of wire through which varying currents could be passed. The voltage applied to the tube was 60 volts.

The results obtained are tabulated below:

		$\frac{I_1}{I_2}$ in Pure Hg tube					$\frac{I_1}{I_2}$ in the Amalgam tube			
H in Gauss		0	4	8	12	16	0	4	12	24
Hg	5791	9·0	8·0	7·0	5·8	3·4	2·5	2·1	1·9	1·6
	5770	9·0	8·4	7·4	6·1	4·0	3·0	2·7	2·4	2·0
	5461	5·2	4·6	4·4	3·9	3·5	2·0	1·8	1·6	1·4
Cd	6438						2·0	1·8	1·5	1·4
	5086						1·8	1·7	1·6	1·4
	4800						1·6	1·5	1·4	1·3

The above experiment thus brings out the following facts:—

(*a*) The depolarisation of the Hg lines increases considerably when mixed with excited cadmium atoms.

(*b*) The depolarisation increases with increasing transverse magnetic field, and in a field of 100 Gauss the depolarisation seems to be complete.

B. N. Ghosh.

Science College,
Patna,
June 12, 1941.

AN IMPROVED METHOD FOR THE DETERMINATION OF "PROTHROMBIN TIME"

Quick[1] has described a method for evaluating 'prothrombin time' by noting the time-interval for the formation of a clot in the plasma when it is mixed with a solution of thromboplastin and calcium. The procedure may be briefly represented as follows:—[See (A).]

(A) 0·1 c.c. Plasma (oxalated) + 0·1 c.c. Thrombo-plastin sol. (prepared from rabbit's brain) + 0·1 c.c., 0·1 M. $CaCl_2$ ——> Appearance of clot (Prothrombin time) = 12 to 13 seconds.

(B) 0·2 c.c. Plasma (oxalated) + 0·2 c.c. Russel Viper Venom (1–10,000) + 0·2 c.c., 0·025 M. $CaCl_2$ ——> Appearance of clot (Prothrombin time) = 18 to 25 seconds.

'Prothrombin time' obtained by this method has often yielded divergent results and minor modifications in the details of the technique have therefore been recommended by Dam,[2] and Kato and Poncher,[3] with a view to obtain more uniform and dependable results. However, apart from the technical difficulty of observing accurately the end-point (formation of the fibrin web in a rather opaque solution provided by the rabbit-brain extract), the chief disadvantage of Quick's technique in routine determinations lies in the fact that a fresh thromboplastin preparation has to be obtained every time that a determination is made —a procedure which is not only inconvenient and time-consuming, but is open to the objection that the thromboplastin preparation employed in the reaction, being freshly made each time, may and actually does, vary in potency from batch to batch. In a standard technique, on which the interpretation of data of diagnostic and prognostic value will depend, such variation in potency of a reaction component is obviously not desirable, and may give misleading results.

Taking advantage of the thromboplastic property of Russel Viper Venom, Fullerton[4] has recommended a modified method wherein the thromboplastin preparation from rabbit's brain extract is replaced by a solution of Russel Viper Venom of standard strength. [See (B).]

The author recommends that every time a prothrombin test is performed, an ampoule

containing viper venom (0·1 mg.) in dry form (commercially available as "Stypven" or "Russven", B.W. & Co., or Boots Pure Drug Co.) should be dissolved in 1 c.c. distilled water *immediately before use.* The viper venom in solution, according to the author, is liable to rapid deterioration.

Hobson and Witts[5] have recently reported that the Fullerton technique, while an improvement on the original Quick procedure, is still not quite satisfactory. When viper venom *alone,* even in its optimum concentration of 1–20,000, is used as the thrombokinase in the reaction, the clotting time obtained is often very much delayed (18 to 25 seconds instead of 12 to 13 seconds by the Quick method) and the range of variation is also liable to be wider than usual. To obviate these difficulties, the authors have suggested the addition of *lecithin* to the venom solution. [See (C).]

the thromboplastin and calcium solutions were added separately as in (B)], thereby resulting in an increase in concentration of prothrombin in the reaction mixture by about 33 per cent. A further improvement was rendered possible when it was discovered that, contrary to previous conceptions, a solution of viper venom (1 in 20,000) in water or in 0·025 M. $CaCl_2$ can be maintained under stable conditions under toluene at a temperature of about 5° C. A stock solution of venom can therefore be used in prothrombin determinations instead of a fresh solution prepared from dry venom for each test, as is demanded by the Fullerton (B) technique. The simultaneous addition of thromboplastin and calcium further brings down the clotting time to 8 seconds, thus making it unnecessary to add lecithin to the venom solution, as recommended by Hobson and Witts (C).

(C) 0·1 c.c. Plasma + 0·1 c.c. R.V. Venom–lecithin reagent + 0·1 c.c. 0·025 M. $CaCl_2$
(lecithin 5 mg./c.c. venom)
———> Appearance of clot (Prothrombin time) = 8 to 11 seconds.

(D) 0·2 c.c. Oxalated plasma + 0·2 c.c. R.V. Venom (1–20,000) in 0·025 M. $CaCl_2$ ———
(kept at a temp. of 37°–38° C.) (from stock solution)
———> Appearance of clot (Prothrombin time) = 8 seconds.

While working on the relationship between plasma trypsin and blood coagulation, it was necessary to determine the 'prothrombin time' in a number of physiological and pathological conditions as a preliminary to further work. After many trials with both the Quick (A) and the Fullerton (B) techniques, it was realised that there is considerable room for the improvement of this useful clinical test. Experience with the Fullerton technique indicated that the method would yield quite satisfactory results, if the dilution of the prothrombin in the plasma could be reduced and the speed of the thromboplastin—prothrombin—calcium reaction accelerated. It was found that both these problems could be solved by adding *directly* to the plasma 0·2 c.c. of 1 in 20,000 venom solution in 0·025 M. $CaCl_2$ as shown below:—[See (D).]

The total volume of the reaction mixture was thus reduced to 0·4 c.c. [instead of 0·6 c.c. when

The advantages of our method may be briefly stated as follows:—

(*a*) It permits the employment of a stable stock solution of thromboplastin of constant potency. In routine testing of a large number of samples, the availability of a ready-made standardised thromboplastin solution is often a real advantage.
(*b*) The addition of thromboplastin and calcium in one solution abolishes the time-interval of the thromboplastin—prothrombin reaction, which can take place only in the presence of calcium.
(*c*) The 'Prothrombin time' is speeded up on account of the increased concentration of prothrombin in the reaction mixture.
(*d*) The clot formed is well marked, as the fibrinogen is not diluted to the same extent as in Fullerton's method.

Since the isolation of Vitamin K and its therapeutic utilisation in certain hæmorrhagic conditions, the determination of the prothrombin level in blood has attracted considerable attention. The improved method for the determination of 'Prothrombin time' outlined here will, it is hoped, be found of particular interest

to clinical hematologists and other laboratory workers.

The details of this investigation will appear elsewhere. Our thanks are due to Colonel Sir Ramnath Chopra for his encouragement and guidance.

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June 18, 1941.

[1] Quick, *J. Amer. Med. Assn.*, 1938, **110**, 1658.
[2] Dam, Tage-Hausen and Plum, *Lancet*, **1939, 2,** 1157.
[3] Kato and Poncher, *J. Amer. Med. Assn.*, 1940, **112,** 749.
[4] Fullerton, *Lancet*, August **17**, 1940, **195.**
[5] Hobson and Witts, *Lancet*, Aug. **24**, 1940, **247.**

THE INHIBITORY EFFECT OF EXCESS OF CALCIUM ON QUICK'S PROTHROMBIN TIME

IN the course of our attempts to determine the prothrombin time in healthy adults and in certain clinical conditions, we noted that the prothrombin time was definitely and consistently longer when the calcium chloride solution used was a M/10 solution, instead of M/40 solution, recommended by Quick and Leu.[1] We were led to suspect an inhibitory action of a moderate excess of calcium as a result of a series of observations made in October 1940 (Table I).

TABLE I

Subject	Prothrombin time in seconds	
	M/10 solution	M/40 solution
1. *D.M.* H.M. 28 .	50	15
2. *K.S.* H.M. 16 ..	60	22
3. *V.A.* H.M. 15 ..	59	17
4. *S.A.* H.F. 28 .	42	14
5. *N.* H.M. 50 ..	45	16

On looking into the literature on the subject we came across a few and vague statements regarding the inhibitory action of excess of calcium on blood coagulation. Ferguson[2] states that a number of authorities have demonstrated the anti-coagulant effects of calcium salts. He refers to the experiments of Horne,[3] confirmed by Sabbatini, which showed that clotting was inhibited by an excess of calcium. Mellanby[4] and Rettger[5] also confirmed Horne's observation. Fergusson points out, however, that the question has not been fully elucidated and that excess of any neutral salt, preserves the fluidity of the blood. Von Zarday,[6] restudied the *vitro* optima, minima and maxima for both calcium and citrate in blood coagulation, and showed that the anticoagulant effects of excess of calcium could be overcome by the subsequent addition of citrates.

Quick[7] observed that, while calcium was essential for clotting, a moderate excess of calcium inhibited the effect. "The optimal concentration of calcium for clotting oxalated plasma is M/100 to M/70. On increasing the calcium concentration above this level clotting is inhibited." One of his recent papers[8] entitled "Calcium Factor in Quantitative Determination of Prothrombin" is not locally available. His latest contribution on the subject[9] contains the following observations and views. "By mixing plasma containing a fixed excess of oxalate with thromboplastin and then adding calcium chloride solution, optimal coagulation was obtained for a wide range of calcium concentrations as shown in Table IV. Theoretically, a calcium chloride concentration of 0·0075 M will precipitate all of the oxalate contained in the plasma, but curiously a concentration as low as 0·00065 M is still able to cause clotting. From 0·0025 to 0·025 M the clotting time is fairly constant and corresponds rather closely to the rate observed after adding thromboplastin to plasma containing no anticoagulants. This suggests that for these concentrations of calcium, the prothrombin is quickly and completely regenerated and will cause clotting in the period normally observed

for a fixed amount of prothrombin. Naturally, for low or inadequate amounts of calcium not all of the prothrombin can be reformed. *For higher levels of calcium the depressing action of this ion begins to manifest itself."*

In reply to our letter written in October 1940, mentioning our findings and requesting his comments, Professor Quick replied in the last week of February this year. "In regard to your first observation, calcium chloride beyond a certain concentration depresses coagulation. I think this observation is linked with the fact that prothrombin itself is a calcium compound and that the remainder of the calcium of the blood is not needed for coagulation. (I am sending you a reprint on this subject.)" The reprint, eagerly awaited, has not reached us yet.

We therefore felt it desirable to reinvestigate the question. Quick's test was performed using eight different concentrations of calcium chloride solution. The results presented in Table II confirm our early findings, regarding the inhibitory action of a moderate excess of calcium on Quick's test.

TABLE II

Quick's Prothrombin time in seconds with different concentrations of Calcium Chloride Solution

Subject	M/5	M/10	M/15	M/20	M/30	M/40	M/80	M/160
K.Y. ..	80	35	25	22	19	17	17	17
M.S. ..	130	39	31	24	20	19	19	19
B.Ch. ..	140	43	29	23	23	21	21	21
K.S. ..	122	37	27	25	21	16	18	17
D.P. ..	108	46	31	24	22	20	19	20
A.P. ..	115	47	31	23	21	20	20	..

Whatever may be the theoretical explanation for the above findings, we feel justified in publishing our results with a view to stimulate further work on this very important but neglected question.

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Department of Physiology,
Andhra Medical College,
Vizagapatam,
May 15, 1941.

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[3] Horne, R. M., *J. Physiol.*, 1896, **19**, 356. Quoted, by Ferguson.
[4] Mellanby, J., *J. Physiol.*, 1908-09, **38**, 28, 441. Quoted by Ferguson
[5] Rettger, L. J., *Am. J. Physiol.*, 1909, **24**, 406. Quoted by Ferguson.
[6] Von Zarday, I., Quoted by Ferguson.
[7] Quick, A. J., *J. Immunol.*, 1935, **29**, 87.
[8] —, *Proc. Soc. Exper. Biol. and Med.*, 1939, **40**, 206.
[9] —, *Am. J. Physiol.*, 1940, **131**, 455.

AIR TEMPERATURES GIVEN IN METEOROLOGICAL REPORTS COMPARED WITH THOSE ON THE FIRST FLOOR OF A BUILDING AT POONA

THERMOMETERS at all meteorological observatories in India, are exposed in a Stevenson Screen with its bottom at a height of 4 ft. above ground. The temperature registered by these thermometers is that experienced by persons who live and work in the open without exposure to direct sunlight during the day or to sky radiation at night. But people spend most of their time indoors, especially in towns, and the temperatures to which they are exposed are generally more equable than in the open.

This note gives the results of a comparison for one year between the temperatures obtained under standard conditions at the Poona observatory and the temperatures on the first floor of the Poona Meteorological Office building.

A thermograph by Casella is kept on a table on the first floor landing near a broad door

leading to the balcony. The landing is continued on either side in the front verandah of the building, which is screened from the outside by mosquito-proof wire-netting. The thermograph is at a height of 3½ ft. above floor level and 21 ft. from the ground. The Stevenson Screen is situated in the compound of the Office at a distance of about 200 ft. from the building.

The daily values of maximum and minimum temperatures for a single year 1938 were tabulated from the thermograms. The readings of the thermograph were compared twice a month with those of an Assman thermometer.

The monthly mean values of the maximum and minimum temperatures on the first floor together with the differences from the corresponding monthly means of temperatures in the Stevenson Screen are given in Table I.

As may be expected, the air inside the building is cooler during day and warmer during night, the contrasts being greater in the case of the minimum than in those of the maximum temperatures. The differences are least in the monsoon season and greatest in winter and spring.

The diurnal range of temperature inside is similar to that outside in its annual variation. The range is least in June–July and greatest in February–March; and the magnitude of the diurnal range is much smaller inside; on the average of the year it is only 7° F. inside as against 24° F. outside.

The highest maximum and the lowest minimum recorded on both the sites in each month are given in Table II.

The tabulations also show that the differences between the inside and outside retain the same sign day after day although differing in magnitude. On rare occasions in the rainy season the maximum inside is found to be higher than the maximum outside when a sudden shower

TABLE I

First Floor.—Monthly means of max. and min. temperature (° F.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
Maximum temparature	77·3	78·5	87·2	90·4	88·5	80·0	78·4	78·5	79·4	78·6	76·7	74·9	80·7
Difference .. (S.S.—1st Floor)	+12·1	+10·6	+10·8	+10·2	+ 8·0	+ 2·6	+ 2·4	+ 3·8	+ 5·1	+ 6·9	+ 9·7	+10·1	+ 7·7
Minimum temparature	68·6	68·2	76·9	80·6	80·0	77·6	76·0	76·0	75·9	73·9	69·3	65·5	74·0
Difference .. (S.S.—1st Floor)	−13·0	−15·8	−13·5	−10·6	− 7·8	− 5·2	− 4·7	− 5·2	− 6·7	− 9·1	−12·7	−14·4	− 9·9

TABLE II

Highest max. temperature (° F.)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1st Floor	80	84	92	94	94	87	82	82	85	82	82	78
S.S.	95	95	102	105	104	94	88	89	92	91	89	91

Lowest min. temperature (° F.)

1st Floor	67	64	72	76	78	76	74	74	74	72	65	61
S.S.	51	45	55	58	65	68	69	69	65	54	45	43

at about the time of the maximum temperature cools the outside air.

V. Doraiswamy Iyer.

Meteorological Office,
Poona,
May 26, 1941.

ANALYSIS OF THE OIL OF *ZIPHIUS CAVIROSTRIS* (GOOSE-BEAKED WHALE)*

In July 1940, a member of the Ziphidiæ, identified as *Ziphius cavirostris* at the Fisheries Department, Colombo, was washed up alive on the west coast of Ceylon at Ratmalana. Specimens of this animal have been reported previously[1-6] but no analysis of the oil of this very rare Cetacean appears to have been carried out. It was therefore considered of interest to record the analytical characteristics of the oil from this mammal.

The only sample of "body oil" obtainable was from a piece of blubber which had been left in an open dish for three days and from which the oil had drained away. Unfortunately rancidity had set in. The values obtained are given below; and for comparison, the analytical characteristics of Dolphin oil are also provided.

I must thank the Director of Fisheries for the facilities afforded to me in the Laboratory of the Fisheries Department.

N. G. Baptist.

Fisheries Dept. Laboratory,
Ceylon,
June 26, 1941.

* (From the Laboratory, Fisheries Department, Ceylon.)

[1] Longman, *Proc. Roy. Soc.*, 1919, Qld. **31**, 90, pl. iii and iv (near Maryborough, S. Qld.)

[2] Olivier, *Proc. Zool. Soc.*, 1922, p. 576.

[3] Dammerman, *Treubia*, 1926, **8**, 336, pl. iii (N. coast of Java).

[4] Vinciguerra, *Ann. Mus.* civ, *St. Nat.*, Genova, 1927, **52**, 232 (Ligurian Sea).

[5] Scott and Lord, *Proc. Roy. Soc.*, Tasmania, 1928, p. 156 (Preservation Island, Tasmania).

[6] Hale, *Rec. S. Austr. Mus.*, 1931, **4**, 312 (New Ireland).

[7] Hilditch, *Fats and Waxes* (1924).

	Sp. Gr.	Ref. Ind.	Sap. No.	Sap. Eq.	Iodine abs. %	Free F. A.		Non-sap.
						Acid No.	As Oleic acid	
Ziphius Head oil	$0{\cdot}904^{29°/29°}$ ..	$1{\cdot}568^{29°}$	235-240	234-238	26	1·2	0·61%	14·7%
Body oil	$0{\cdot}920^{29/29°}$ ..	$1{\cdot}384^{29°}$	113	496	50	20	10·1%	8·3%
Dolphin[7] Jaw oil	$0{\cdot}925^{15/15°}$ ..	$1{\cdot}452^{20°}$	270-290	195-205	32	2·4	1-2%	fairly high
Body oil	$0{\cdot}927^{15/15°}$ ..	$1{\cdot}471^{20°}$	187-220	255-300	100-127	2-12	1-6%	..
Sperm Whale[7] Head oil	$0{\cdot}878^{25°/25°}$ ..	$1{\cdot}459^{25°}$	140-144	390-405	60-76	3-8	15-5%	39·43
Body oil	0·876 ..	$1{\cdot}462^{25°}$	122-130	430-460	88-93	2 4	1-2%	33·44

A LONG-GLUMED MUTATION IN RICE

Generally speaking the cultivated varieties of rice, *Oryza sativa* L., possess minute outer glumes measuring from 1·5 to 3 mm. Even the wild rice, characterized by complete shedding of grain, has very small glumes. However, there are certain varieties of *O. sativa* whose glumes are longer, extending up to the upper limits of lemma and palea. In certain of such varieties the glumes are even longer than the spikelets. These are

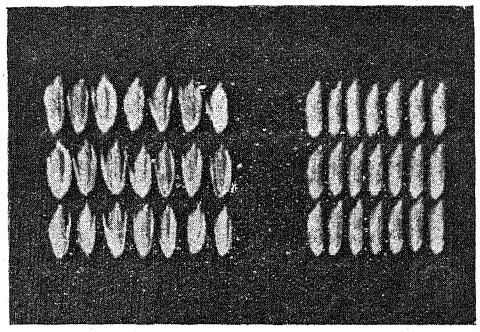
mentioned by Roschevicz[10] as *Oryza sativa* L. var. *longiglumis* Roshev., in contrast to a distinct species, *O. grandiglumis* (Doell.) Prod., in which the outer glumes are as large and wide as the lemma and palea.

Among the varieties of *O. sativa* the character of long glumes, although morphologically distinct, has not been utilized uniformally by various workers who have made attempts at classification of the innumerable varieties of common rice. Thus, to mention some, Kikawa,[6] Graham[3] and Beale[1] do not utilize the character in their classification of rice, while Tanaka,[6] Hector and Sharangpani[4] and Kashiram and Chetty[5] have used long outer glumes as one of the characters for classification.

Inheritance studies so far reported show that the long-glumed condition is usually recessive. Okada,[7] van der Stok[11] and Parnell *et al.*[8] each reported dominance of short glumes and a monogenic segregation 3 short : 1 long-glumed plants. Chao,[2] however, found a 15 : 1 ratio of the two types of plants respectively. In contrast to these results Ramiah *et al.*[9] reported a 1 : 2 : 1 ratio of short, intermediate and long glumed plants respectively. These authors illustrate the middle class from almost a short-glumed to a long-glumed condition in which the glumes are of varying lengths, but do not exceed the length of lemma and palea. In the third category the glumes extend out over the spikelet, like the original long-glumed parent. Since the F_1 is intermediate, it is rightly concluded by them that the character of long-glumes is partially dominant.

In the Bombay Province, out of many hundreds, only two varieties with long-glumes, Pankhali-Kamod and Rakkibhatta, are known to us. The former is grown in Gujarat and is scented, while the latter comes from Karwar in the southern portion of the Province.

During the crop season of 1940, while making individual plant selections from a bulk sample of an early local Kolamba variety, a plant with long glumes was observed. Since all other plants from the variety had the usual short glumes, the off-type plant was either a mechanical mixture, a natural hybrid or a mutation. From the shape of its grains, it was clear that no mechnical mixture of such an off-type plant could occur as there is no such variety of Kolamba in existence. This also rules out the possibility of a natural cross. Therefore, it appeared a case of a mutation (Fig. 1).



Long Glumed Normal

FIG. 1

Twenty seeds from the off-type plant were grown in a pot during the winter of 1940 to observe the breeding behaviour of the long-glumed Kolamba plant. Of these, 18 plants showed spikelets with long glumes, while two plants did not put forth any panicles. It is, therefore, certain that long-glumed condition in this new type of Kolamba arose due to mutation.

Kolamba is one of the most important, fine-grained variety in the northern districts of Konkan, which is the predominant rice tract of the Province. The Agricultural Department in Bombay has released a number of superior strains from this variety. Some of these are replacing even the coarser early and mid-late varieties. Since Kolamba strains are entirely green in vegetative parts, there is no outstanding discriminating character, except differential flowering, which helps to distinguish them from local coarse varieties. If such a conspicuous character as long glumes could be introduced without impairing any of the agricultural characters of the improved Kolamba strains, it would greatly help to rogue the

fields and will also assist in keeping an accurate record of the areas under improved strains of this variety.

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M. V. GADKARI.
G. G. PATIL.

Rice Breeding Station,
Karjat,
June 25, 1941.

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[3] Graham, R. J. D., *Mem. Dept. Agri. Ind. Bot. Ser.*, 1914, **6**, 209.

[4] Hector, G. P., Sharangpani, S. G., *et al.*, *Ind. Jour. Agri. Sci.*, 1933, **4**, 1.

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[8] Parnell. F. R., Rangaswami Ayyangar, G. N., and Ramiah, K., *Mem. Dept. Agri. Ind. Bot. Ser.*, 1917, **9**, 75.

[9] Ramiah, K., Jobitharaj, S., and Dharmalinga Mudaliar, S., *Mem. Dept. Agri. Ind. Bot. Ser.*, 1931, **18**, 229.

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[11] Stok, van der J. E., in *Handbuch der landwirtschaftlichen Pflanzenzüchtung*, by C. Fruwirth, Berlin, 1923.

THE STRUCTURE OF THE CHROMOSOME

WHILE our understanding of nuclear structure has made rapid strides of advance, there still remains a sharp cleavage of opinion on the question of the structure of the chromosome. Undoubtedly a large measure of this difference is due to the peculiar temptation of some cytologists to deny the validity of visual observation. With improved methods of fixation and staining, Professor Gates and his students have, in recent years, gathered overwhelming evidence in support of the view that the somatic anaphase chromosome is bipartite. Dr. Darlington[1] faces this mass of observational evidence with a *bubble* theory which in reality is a revival of a conception prevalent in 1911 that anaphase and telophase chromosomes developed vacuoles or alveoli in passing into the resting condition. Observations on the satellites during somatic mitosis have yielded further crucial evidence in support of the double nature of the somatic anaphase chromosomes. In root smears of *Crocus sativus* stained with decolourised basic fuchsin, Gates and Pathak[2] found during telophase, one of the three satellite chromosomes bipartite with a split satellite.

In the course of my investigations on the somatic chromosomes of the Liliaceous genus *Muscari*, I have found in root smears, cases in which the satellites of one of the anaphase chromosomes was split, demonstrating unmistakably its double nature. One such anaphase is figured here and the long arm of one chromosome can be seen to bear a split satellite at its end, the threads diverging widely apart. This chromosome has a prominent secondary

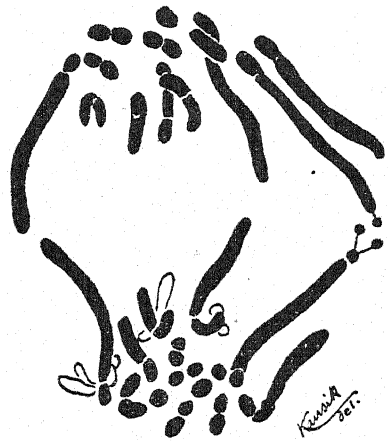

FIG. 1
Root smear of *Muscari moschatum*
Anaphase showing one of the long chromosomes with a split satellite. × 3600.

constriction in the long arm. The split condition of the satellites does not appear often as it depends on critical fixation and the orientation of the chromosome.

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Bangalore,
June 14, 1941.

[1] *Nature*, 1938, **141**, 371.
[2] *Ibid.*, 1938, **142**, 156.

NOTE ON THE ORIGIN OF THE MAGNETITE DEPOSITS OF MAYURBHANJ STATE, ORISSA

THE magnetite deposits of Dhalbhum (a subdivision of the Singbhum District of Bihar) and Mayurbhanj attracted considerable attention from Geologists after the presence of the valuable metal vanadium in these ores was proved by Ray[1] and later confirmed at the Imperial Institute. Dunn and Dey[2] described briefly the petrographical characters of the basic and ultrabasic rocks with which the ore bodies are associated, and discussed their genesis. According to them the magnetite deposits are due to the breakdown of the previously crystallised iron-rich olivines and pyroxenes by the action of the residual solutions, the MgO of which replaced the FeO of the ferromagnesians by base exchange. The authors are of the opinion that the 'alteration of the titaniferous pyroxenes and olivine was quite capable of supplying all the iron and perhaps titanium, which then separated out as titanomagnetite'. A necessary corollary of the enrichment of the residual solutions in FeO by the above process is considerable alteration of the associated rocks, such as serpentinisation, uralitisation and chloritisation of ferromagnesians, saussuritisation and chloritisation of felspars, albitisation of felspars, etc.

During the past three years the writer of the present note has been making a thorough and systematic study of the basic and ultrabasic rocks of Mayurbhanj and so far as the latter area is concerned his observations do not confirm the above explanation. No doubt the rocks have undergone deuteric alterations in many places but the magnetite deposits do not show any genetic association with altered rocks. The gabbro rocks range from anorthosites to norites. The chief minerals of these rocks are plagioclase felspars of the composition of labradorite, orthopyroxene of the Bushveld type and ordinary orthopyroxene (both enstatite and hypersthene), clinopyroxene, hornblende, olivine, biotite, apatite, quartz and magnetite. Magnetite is of two generations, the later and more important deposition was clearly the last mineral to crystallise as has been noted by Dunn and Dey.

It may be noted in this connection that orthopyroxene of the Bushveld type which consists of lamellar intergrowths of clinopyroxene in orthopyroxene host has been noted by the writer of this note for the first time in these rocks. This mineral has not been recorded in any of the orthopyroxene bearing rocks of India, as the intergrowths, which are due to exsolution of diopside, are destroyed during recrystallisation. Magnetite of the second generation is widely disseminated in these rocks and not only fresh rocks are more common than altered rocks but also magnetite deposits, both small and large, do not show any associational relationships with the altered rocks. Certain rocks may be described entirely as 'magnetite-rich facies' of the anorthosites. The study of thin sections reveals that the magnetite has replaced felspars and pyroxenes in these gabbros. It fills up the interstices between the already crystallised minerals and encroaches upon their margins, sometimes entirely replacing them.

The mode of occurrence of the magnetite and its widespread distribution in fresh rocks indicate that it is of primary magmatic and high temperature metasomatic origin as has been recently suggested by Alling[3] for the Adirondack magnetites. Moreover the gabbro rocks are rich in MgO as is to be expected from their richness in early crystallised pyroxenes, but this is against the requirement of the theory of base exchange.

Primary micropegmatite has been noted in the gabbro in a few localities far away from the exposures of Singbhum granite and granophyre, the micropegmatite of which, at least in this area, is of secondary cataclastic origin. This, together with the unmetamorphosed nature of the striped orthopyroxene bearing gabbro, points to its younger age compared to the age of the granite-granophyre.

The detailed and full account of these rocks will be published shortly when the evidences

for the above conclusions will be fully discussed and the petrology of the rocks fully described.

S. C. CHATTERJEE.

Ranchi,
June 30, 1941.

[1] *Proceedings of the 19th Indian Science Congress*, 1932, 212.

[2] *Transactions, Mining and Geological Institute of India*, 1937, **31** ; *Memoir Geological Survey of India*, **49**, Part 1, 215-216.

[3] *Economic Geology*, 1939, **34**, p. 166.

A MARGOSA TREE WITHOUT THE BITTER PRINCIPLE

AT Kothanur village, 13 miles to the northeast of the Kollegal town in the Coimbatore District, there is a big banyan tree (*Ficus bengalensis* Linn.) which has a spread of nearly three-fourth acre enclosing within its trunk a large margosa tree (*Azadirachta indica* A. Juss.) of about 60 feet in height and 18 inches in diameter. The margosa overtops the banyan at its summit. The aerial roots of the banyan tree would have entwined the margosa tree to start with, as is commonly met with in combinations of the banyan with other species and after many years' growth would have formed a natural graft with the main stem of the margosa. The enclosed portion is about 10 feet in height and the trunk of the margosa tree cannot be seen to this height from the base. At this height a stout aerial root of the banyan tree is found to grow into a hollow in the trunk of the margosa tree caused by some decay in its heartwood; to all appearances the basal portions of both the trees have fused into one another. Evidently stem fusions have taken place in many places between the margosa tree and the banyan tree helped by the pressure exerted by the banyan.

The peculiarity of this margosa tree is the absence of the bitter principle in its leaves. The writer tasted them and some specimens of leaves brought by him to Coimbatore were declared by all who tasted them to be without the bitter principle found in margosa leaves.

The only plausible explanation for this peculiar phenomenon is that in many places the vessels and the sieve tubes of the margosa may have fused with those of the banyan as a result of "grafting" and the sap of the banyan is influencing the sap of the margosa.

Many seedlings of margosa from seeds fallen from this tree are growing under the parent tree; the leaves of these seedlings are normal and contain the usual bitter principle. The natural inference is that the absence of the bitter taste in the leaves of the margosa growing in combination with the banyan is not a genetic modification but merely the influence of the sap of the banyan on that of the margosa. Here is probably an extraordinary case of the influence of an unnatural stock (the banyan tree) on a scion (the margosa). It is interesting to note that such grafts could take place in nature between two widely different families of plants, *i.e.*, between banyan, a member of *Moraceæ* and margosa, a member of *Meliaceæ*.

These "fused trees" have become very famous in the locality and the neighbourhood. People attribute strange powers to this combination especially to the margosa due to the absence of the bitter principle in its leaves. Offerings are made by villagers to this unusual margosa tree on Mondays and Fridays.

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REVIEWS

Man on His Nature—*The Gifford Lectures*, Edinburgh, 1937–38. By Sir Charles Sherrington, O.M. (Cambridge University Press), 1940. Pp. 413. Price 21*sh.* net.

This book embodies twelve lectures, which form a comparative study of the modern biologist's attitude towards the mysteries of life and the views propounded by Jean Fernel, a physician philosopher of the sixteenth century. His work "On Hidden Causes" printed in 1548 was one of the most widely read books of the time, judged by the number of editions it passed through. Its reputation and popularity must have been largely due to the fact that it was a clever and fairly comprehensive exposition of some of the obscure philosophical and theological problems which agitated the mind of Christendom. It is only natural that Sir Charles Sherrington, whose whole life has been spent on the detailed investigation of the structure and function of the nervous system, should have made Fernel's work the text for his lectures. They deal with independent topics and can be read without a previous knowledge of the earlier discourses, but yet together they constitute a composite dissertation on the fundamental theme whether the modern scientific researches justify a logical division of matter into living and non-living bodies. Firm in the grasp of his subject and with an outlook rare in its sympathy and range, the author has striven to prove that the boundary line separating the sentient and the non-sentient objects is only apparent, but at bottom the biological processes are indistinguishable from the complex of interatomic physical and chemical electrical changes.

Every student of biology is aware of the competing claims of the mechanistic and vitalistic theories offering solution to the mystery of life, which, in spite of the immense advances in biology and physical sciences in recent times, still remains a deep mystery. It must be remembered that all theories and hypotheses,—more or less in the nature of accretion of analogies,—are not all inferences from positive knowledge, but to a very large extent must be "correct guesses". If nothing is to be gained by claiming living matter as colloidal, there is equally nothing to be gained by claiming that life processes belong to the province of atomic physics. The mystery of life is just as great now as it was to the first speculator, for the obvious reason that a "subject" in the philosophical sense cannot be also an "object". We may know all about the physical machinery, but when we come to analyse "consciousness" and "mind", we needs must enter the region of speculation, for neither the one nor the other can be seen and handled, except what we know of their manifestation. Pasteur has been called a vitalist, but in 1884 he wrote "not only have I not set up as absolute the existence of a barrier between the products of the laboratory and those of life, but I was the first to prove that it was merely an artificial barrier, and I indicated the general procedure necessary to remove it by knowing that it would be necessary to have recourse to those forces of dissymmetry which you have never employed in your laboratories". Sir William Bate Hardy adds "and yet the hypothesis of a special vital force and the search for it is as likely to lead to our goal as any other. I would even go further and say that the physical and chemical improbabilities of living matter are so great as to make an hypothesis of special creations more restful and almost as valid as that of continuous evolution."

We have read the lectures with profound interest, but nevertheless we cannot disguise from ourselves the feeling that "the biologist's philosophy" so fearlessly and invigoratingly expounded in them leaves a sense of incompleteness. This is not due to any want of adequacy and clarity of treatment, for few books can be regarded as more clear, and comprehensive, or fuller in respect of experimental details supporting the arguments. It is the very nature of the subject that must baffle ultimate analysis. We may succeed in finally reducing the concept of life as a mere convention, but can we also treat consciousness and mind,—the two "functions" of life,—as mere phases of physical phenomena. "Is there any guess which comes within whooping distance of

the shifts and tricks by which the primordial slime clothed itself in diffraction gratings to give the birds the colour they need in a tropical forest?" The inner sanctuary of biology may not open its doors,—perhaps not at all,—by uttering the physico-chemical barley, wheat, but possibly a glimpse into the inner treasure vaults may be vouchsafed by *Upanishadic* sesame.

The twelve lectures deal with topics such as Nature and Tradition, The Natural and Superstition, Life in Little, The Wisdom of the Body, Earth's Reshuffling, A Whole Presupposed of its Parts, The Brain and its Work, The Organ of Liaison, Brain Collaborates with Psyche, Earth's Alchemy, Two Ways of One Mind and Conflict with Nature—thus traversing the whole field of known facts in science, physical, biological and mental. On going through the chapters, we are tempted to exclaim the excellent sentiments so nobly expressed by the author, "There will be much to which man has not access. The distances are immense and he is near-sighted. He peers into a small patch and what he sees there he submits to his reason which after all is very newly hatched. What wonder if his conclusions be meagre and insecure. What wonder they are narrowly anthropomorphic. Such they must be." The central point of enquiry is, "Is there a Mind that directs and controls the operations of organic and inorganic Nature." If there is none, then it is arguable that the boundary line separating Nature and Mind vanishes; in the sense that Mind is self-conscious and conscious of the electrical-chemical forces by which matter exists, Mind and Nature are different. But are these "forces" blind, fortuitous and independent? They are known to be governed by definite laws expressed mathematically or in the language of physics and chemistry. These are the Laws of Nature. But what is Nature? Is it the assemblage of phenomena in the objective world, does it also comprehend the subjective world? We are aware that the mental phenomena are to a large extent—the purposeful and directed phenomena—governed by intelligence. Is there an intelligence controlling the forces and phenomena of the objective world? Perhaps a tentative answer is furnished by the query —not an impertinent one,—is the book under review, undoubtedly a remarkable event, just a product of atomic physics and chemistry, or have the operational processes culminating in the book been guided, directed and controlled by a purposeful intelligence? Sir Charles Sherrington has answered this and other intricate questions in his own inimitable way.

This book has brought together several provocative thoughts, has analysed them and shown the many inherent difficulties confronting the enquiring mind. Most of its contents are stimulating and easy to digest. None can read the volume without the sense that Sir Charles Sherrington has felt the grand sweep and majesty of the theme which he has set out to expound in a firm, clear and crisp style, so rare in scientific treatises dealing with philosophical problems. We have the intense conviction that this book is a masterpiece of balanced exposition of problems which lure and perplex thoughtful minds.

Religion in Science and Civilization. By Sir Richard Gregory, Bart., F.R.S. (Macmillan & Co., London), 1940. Pp. xii + 366. Price 12*sh.* net.

"The other day I listened with great pleasure to Sir Richard Gregory's Aldred Lecture, and admired once again his instinct for bringing together into the most fruitful association, facts and consequences lying far apart, and extracting wide suggestions and new problems from the assemblage. But the readers of *Nature* do not need to be reminded that Sir Richard was a brilliant editor so that without any sacrifice of its world-wide scientific usefulness he also made this weekly journal a medium of interpretation and understanding between one type of specialist and another and between specialists in general and the man of intelligence and broad curiosity outside the ranks of the specialist worker," H. G. Wells (*Nature*, No. 3729, April 19, 1941, p. 465). These admirable sentiments are not unlike those which a reader of Sir Richard Gregory's sumptuous book would desire to express.

The main thesis of the book is that civilization has progressed on two legs,—Religion and Science,—at first stumbling and righting, but gradually acquiring enough strength to take long and steady strides. Both have the same aim, *viz.*, the investigation of truth, though their methods might differ.

Better appreciation of the service that science and religion are capable of rendering to mankind, though in different spheres, has relegated to oblivion the old and needless controversies, and has led to the realisation that they are complemental to each other. The greatest mistake, that the religious writers and metaphysicians of ancient times made, was to regard their works as final statements of knowledge and what was left for their successors was to repeat them with or without understanding their import. These works acquired or were invested with the authority of Divine revelation and therefore deserved to be respected but not questioned. These sacred books carried with them the seeds of disruption by erecting the word of man as the final authority and when mankind discovered other methods of interpreting the natural phenomena and events, the influence of sacred books must inevitably decline. The blunder we made was that we regarded the knowledge of sacred works as static and that any attempt to question their authority would involve dire consequences. The reign of religion was the reign of tyranny,—the age of suppression of independent enquiry.

Sir Richard Gregory in tracing the cultural history of the different races, has urged that the sacred books and doctrines are to be regarded only as stages in the evolutionary history of human civilization and not as final revelations of truth. The conception of God and the universe which satisfied the primitive people must necessarily appear inadequate to thoughtful men who have explored deeply the mysteries of nature with instruments unknown to the ancient races whose outlook was subjective rather than objective. It is equally untenable to suppose that science has said the final word about the phenomena of the objective world or has rendered a satisfactory explanation of the problems which perplex religion, but the accumulated knowledge of the science of the present century only marks a stage in the development of human mind. Perhaps the task of both religion and science will and must remain a sisyphian role.

Stripped of their dogmatism and their aggressive spirit, religion and science can render invaluable service in the promotion of higher ideals and in the advancement of a higher ethical life based on a spirit of mutual tolerance, accommodation and understanding. Their gifts are liable to be prostituted and then they both suffer a set-back; their mission is fundamentally peace and progress, and the greatest trouble in the way of both is that the civilization of human mind has not kept pace with material civilization. Lurking deep down behind the mind are the worst passions which often with but mostly without provocation involve nations into the savage un-Christian acts of violence. But it is nevertheless fortifying that mankind is imbued with an inner urge towards truth, righteousness, peace, justice and freedom of conscience.

In the twenty-nine chapters, the reader will find a brief and critical review of the culture history of mankind,—tracing its course and movement chiefly with reference to Mesopotamia and Egypt, with just a passing reference to the sacred literature of India (page 70). The Hindu books, though bulk of them is devoted to levitical practices and rituals, contain sections which accept no final interpretation or dogmatic hypotheses as is evidenced by the establishment of several theological schools. These books may not have adopted the evolutionary principles to religious thought, but offer unlimited scope of original enquiry and it is this spirit that has preserved for them their vitality and spiritual value. The ancient religion of the first settlers in the Indo-Gangetic valley was an enlightened democracy from the standpoint of social needs and the highest expression of human instinct for communion with the Supreme Being from the spiritual point of view. Most religions have the same fundamental basis, but all are vitiated by "approach",—the exercises over which there are conflicts and controversies—we are fed on the husk of religion. We have lost the life-giving grain.

Sir Richard Gregory's greatest service in writing this book is the most laudable attempt to restore to the people the spiritual treasure which they have lost. A book that claims to establish kinship between science and religion must have an abiding interest and those familiar with the writings of Sir Richard Gregory will offer a warm welcome to his latest publication. We have found no trouble in following the trend of thought developed in the twenty-nine chapters and that is probably because our conviction has been that there is absolutely no inherent

antagonism between science and religion. Doubters there must be.

The book represents the high water-mark in the comparative study of religion and science, and is entitled to the highest praise as an illuminating contribution to contemporary thought on human affairs.

Printing Inks, Their Chemistry and Technology. By Carleton Ellis. (Reinhold Publishing Corporation, New York, U.S.A.; Chapman & Hall, Ltd., London), 1940. Pp. 560. Price $5.00.

There are not very many books in English language on printing inks and for this reason a book on the subject which is of topical interest in India just now is very much welcome.

The book is divided into 18 chapters. The introductory chapter briefly summarises the contents of the entire book.

The second chapter deals with the history of printing inks from 3500 B.C. to the present day and all the advances that have followed with the development of science.

In Chapters 3 to 15 all the methods of manufacturing printing inks and their raw materials are described in great detail, and any one with some knowledge of chemistry should be able to derive a good deal of benefit from the study of such a valuable book.

Problems arising in the manufacture of printing inks are not generally appreciated and Chapter 16 deals with all such problems such as storage and use of printing inks.

The penultimate chapter describes the testing of printing inks which is scattered all over the literature and has not been collected so far except in this book under review.

Lastly, the problem intimately connected with printing work, *e.g.*, the suitability of paper has also been very thoroughly dealt with. In fact the book really and adequately fills the gap that existed in the technical literature. H. H.

Temperature Measurement. By R. L. Weber. (Edwards Bros., Inc., Ann Arbor, Michigan), 1941. Pp. x + 171.

This book is essentially an experimental study of the subject of temperature measurement. It consists of two parts, the first part being a concise but clear background for the subject and the second, a course of nearly two dozen comprehensive and practically tested laboratory experiments. The fifteen chapters of the theoretical part cover a little more than the field of temperature measurement including, as they do, the briefly and elegantly written chapters on temperature control, calorimetry, and elementary thermodynamics. Similarly the group of experiments described in the second part is more comprehensive than what the title of this book would indicate. Of the twenty-two experiments detailed herein, only about eleven can be taken as direct temperature measurement exercises while the rest cover the interesting subjects of thermal conductivity, calorimetry and temperature variation of the properties like viscosity and magnetic susceptibility.

The treatment of the subject is concise to a fault, however, but no useful or important topic is omitted. The whole work looks like an elegantly written, comprehensive and orderly arranged lecture notes. The university student will find this a useful companion for the study of this specialized subject and the teacher, a modern and comprehensive scheme of experiments which he could profitably incorporate in the usual curriculum.

The get-up of the book leaves nothing to be desired. The use of typescript and clearly drawn diagrams and illustrations make the reading a pleasure. The whole treatment of the subject is modern and the references are given to the up-to-date literature. Besides a tabulation of all the necessary data in the respective chapters, a set of twelve useful tables is given at the end of the book.

In short, this book can be recommended to all the students and teachers alike who are interested in this branch of physics.

G. G. R.

The Ring Index—*A List of Ring Systems Used in Organic Chemistry.* By A. M. Patterson and L. T. Capell. American Chemical Society Monograph Series No. 84. (Reinhold Publishing Corporation, New York; Chapman & Hall, Ltd., London), 1940. Pp. 661. Price $8.00.

In publishing the book under review, the Trustees of the American Chemical Society

Monograph Series, have made a novel departure in a way, in the choice of the subject for a monograph. It is common knowledge that the nomenclature of various types of ring compounds in organic chemistry is often confusing as no standard system of numbering has been adopted in common by chemists all over the world. It is therefore refreshing to find in the present volume all known parent ring systems gathered together and arranged systematically from the simplest to the most complex, for ready reference. The rules and principles on which the nomenclature is based, though appear a little bewildering at the first sight are clearly explained in the introduction and also in the reproduction at the end of the text of an original paper published in the *Journal of the American Chemical Society* by one of the authors (Appendix, pp. 599–611). These will serve also as guide for naming of new ring systems correctly in future. To each system has been given a serial number, facilitating identification in the text. Identifying references to the original literature (as also to Beilstein wherever possible) are given under each heading together with alternative names and systems of numbering. With a little practice it will be found very easy to refer to any required ring system in the text and know all about its nomenclature. The alphabetical index given at the end (pp. 613–61) will also be of great help in finding out any required ring system provided its name is already known. There is little doubt that by publishing this book the authors and the Trustees of A. C. S. Monograph Series have done a really great service to Organic Chemists in helping to standardise their knowledge and to describe new ring compounds in a systematic way. This book should find a place in every chemical library.

P. C. G.

Organic Synthesis, Vol. 20. Charles F. H. Allen, Editor-in-Chief. (John Wiley & Sons, Inc., New York City; Chapman & Hall, Ltd., London), 1940. Pp. 113. Price 10*sh.* 6*d.*

The volume under review is the 20th number of the series entitled "An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals". It contains details for the preparation of the following chemicals: (1) β-(3-Acenaphthoyl)-propionic acid, (2) Acetylacetone, (3) 9-Anthraldehyde; 2-Ethoxy-1-naphthaldehyde, (4) *d*-Arabinose, (5) 1, 2, 3-Benzotriazole, (6) 6-Bromo-2-naphthol, (7) *tert.*-Butyl acetate, (8) Cysteic acid monohydrate, (9) Decamethylene bromide, (10) Dehydroacetic acid, (11) *trans*-Dibenzoylethylene, (12) Dibenzoylmethane, (13) Di-β-carbethoxyethylmethylamine, (14) α, α-Dichloroacetamide, (15) Dimethyl-ethynyl carbinol, (16) 5, 5-Dimethylhydantoin, (17) 2, 2'-Dinitrobiphenyl, (18) Diphenylketene, (19) *n*-Dodecyl *p*-toluenesulfonate, (20) Fumaryl chloride, (21) Furylacrylic acid, (22) *o*-*n*-Heptylphenol, (23) 2-Hydroxy-5-nitrobenzyl chloride, (24) Mandelamide, (25) Methyl β-Bromopropionate, (26) N-methylformanilide, (27) Methyl myristate and Methyl palmitate, (28) Monoperphthalic acid, (29) 5-Nitroindazole, (30) Pentaacetyl *d*-glucononitrile, (31) Phenyl Cinnamate, (32) Picolinic acid hydrochloride, (33) *dl*-Serine, (34) Sodium amide, (35) Terephthaldehyde, (36) α-Tetralone, (37) 2, 3, 4, 6-Tetramethyl-*d*-glucose, (38) *dl*-Threonine, (39) *dl*-Valine. The index at the end comprises material from this volume only.

Since the appearance of the first member of the series in 1921, the utility and reliability of the details available in these publications have been increasingly appreciated by the chemical world, year after year, so much so that no further comment seems to be necessary.

It is gratifying to note that despite the present war conditions, the Editors and the Publishers have been able to carry on this useful work for the benefit of synthetic chemists, and the appearance of the present volume is now all the more welcome.

The present volume is essentially similar in format, to its predecessors. The only apparent difference is that the title of each preparation, instead of being printed at the top of a fresh page is now printed in continuous running order.

P. C. G.

Physico-Chemical Methods. Volume I. *Measurement and Manipulation.* Pp. xv + 686. Volume II. *Physical Properties.* Pp. ix + 580. By J. Reilly and W. N. Rae. (Methuen & Co., London). Price £4–4–0.

This well-known work is now in its third edition and this itself is a testimony

to the wide acceptance of a book of this nature. In the present edition the book has been entirely recast and is issued in two volumes with some additional subject-matters such as on High Pressure Technique and Measures and Units, written with the co-operation of specialists in these subjects.

The chemist must to-day be familiar with a large region of facts and methods, which may be called physical or chemical according to one's bias and training. It is difficult to define the boundaries of the knowledges which alone will be of help to him, and yet a certain choice must be made in order to avoid making the book an unwieldy encyclopædia. The avowed object of the book is to emphasise practical physical chemistry from the industrial chemists' point of view, and so there are included sections on drying and evaporating apparatus, high pressure technique, mechanical separation and other separation processes, distillation and similar unit chemical engineering operations. It appears to us that these sections have but a doubtful utility. They are inadequate from a chemical engineering student's point of view, while for a physical chemist they help only to indicate the scope of the subject, although the authors have endeavoured to aid the readers with a list of references for further study. The question is whether a more useful and up-to-date account should not have been given of the variety of present-day physico-chemical methods, such as in the applications of electron tube circuits, absorption spectroscopy, calorimetry, etc. The diagrams are in many instances poor, such for example as those on pages 473, 475 and 477 in Part I. The indexing is also quite inadequate for a book of this professed general utility. In spite of the above suggestions for improvement, the book is a good compendium of the several physico-chemical methods used in the university and technical laboratories, and will be found of great use in any library. M. A. G. R.

Indian Zoological Memoir VIII—*Hirudinaria* (Indian Cattle Leech). By M. L. Bhatia. (Lucknow Publishing House, Lucknow), 1941. Pp. i–xi + 1–185, with 3 coloured plates and 56 text-figures. Price Rs. 2.

The eighth volume by Dr. M. L. Bhatia of the Lucknow University in the series of the *Zoological Memoirs* edited by Prof. K. N. Bahl is a very welcome addition to the volumes already published in this invaluable series of monographs on Indian animals. The Indian Cattle Leech of the genus *Hirudinaria* is studied as a type of leeches in almost all the Universities of India, Burma and Ceylon, but no detailed description of the animal had so far been published. The author has been working on *Hirudinaria* for a number of years, and has published several papers on its anatomy in various scientific journals. In this *Memoir* he gives a detailed account of the anatomy based not only on his own studies extending over several years, but also on a careful scrutiny of all the available literature on the subject. The anatomical accounts are supplemented, in almost every case, by notes on the histology and physiology of the various organs, and in a separate chapter the bionomics and distribution of the leeches as a whole are briefly discussed. As in the case of other *Memoirs* in the series, detailed directions for practical work form the subject of a chapter at the end of the work.

The descriptive account is clear and concise, and is copiously illustrated with beautiful figures specially prepared by the author. Special attention may be directed to the coloured illustrations of the blood-supply and the figures illustrating the structure of the nephridia and the histology of various organs.

The *Memoir* is very well printed and is exceptionally good value for the price. Both the editor and the author are to be congratulated on the publication of this fine monograph, which is sure to prove of great use both to teachers and students of Indian Zoology. B. P.

Common Marine Food-Fishes of Hong Kong. By G. A. C. Herklots and S. Y. Lin. Second enlarged edition. (University, Hong Kong), 1940. Pp. 89, figs. 51.

This very useful publication deserves special attention of the fisheries departments and marketing officers in this country. In marketing circles, it is well known that the public usually confine their purchases of fish to a very few well-known kinds. The variety of fish available in the tropical waters, fresh, estuarine and marine, is very great, but due to ignorance most of the

people are generally averse to buying even the most nutritious and palatable fishes outside the few with which they are acquainted. To popularize the greater variety of fishes available in the Hong Kong market, the authors have drawn up illustrated accounts of 50 species in English and Chinese and have given 16 European and 18 Chinese recipes for the preparation of dishes from them. The authors state in the introduction that "The fifty species of fish illustrated in this book, and the others also recommended but not illustrated, are all good food-fishes, and the house-wife need not hesitate to buy any one of these even though its shape or colour may appear unusual".

The various parts of the fish referred to in the descriptions are indicated by a labelled illustration and there is a chart showing the seasonal distribution of the 50 species described. By referring to this chart it is possible to find out what fishes are available in different months. The fishes are arranged into five popular groups, namely, Surface Feeders, Perch-like Fish, Croakers, Flat-Fishes and Miscellaneous, and their principal characteristics are noted. A short account is given of the food value of fish and as the flesh of fish deteriorates and decays very much more quickly than the flesh of mammals and birds, useful hints are given about selecting fish in the market. The distinction between fresh and stale fish is tabulated under eight headings and attention is directed to the fact that the white-fleshed fish keep better than the darker-fleshed fish. These latter, oily fish, such as mackerels and herrings, which are highly nutritious, should be eaten absolutely fresh. Directions are also given as to where fish can be purchased at Hong Kong.

Under the description of each fish, its scientific name and an English name are given. The common locally used Chinese names are also included with a romanized form of Cantonese pronunciation. In the description itself attention is directed to the distinctive features of colouration, the general shape and built of the body and to certain peculiarities of structures characteristic of the species. Its normal common size is also noted. Notes on its distribution, seasonal occurrence, retail price and food value are included.

Such a publication is certainly a boon to the fish-eating population of a town and now that fisheries are receiving some attention in India, it is hoped that the authorities concerned will bring out similar pamphlets suitable for the principal towns, such as Calcutta, Bombay, Madras, Karachi, Lahore, etc. Such guides will encourage the sale of greater varieties of fish and, in consequence, the fishermen will be able to realize better prices for their catches.

S. L. HORA.

The Indian Sugar Industry (1940 Annual). By M. P. Gandhi. (Gandhi & Co., 14/2, Old China Bazaar St., Calcutta). Pp. 276. Price Rs. 4–8–0, foreign 12*sh*.

Like its forerunners in the previous years, the 1940 Annual is a wide survey of the position of India's great national industry. In spite of the large impetus given by the tariff protection for the industrial expansion, the Indian sugar industry has passed through many vicissitudes during the previous years, culminating in 1940 in an unprecedented severe crisis. This publication describes in detail how unexpected large supplies of cane, the overproduction of sugar by factories, enhancement of the excise duty, the levy of the cane cess in the U.P. and Bihar and the fixation of high minimum for cane prices, brought about a crisis both for the cane-growers and the factory owners with the result that in the U.P. and Bihar large quantities of cane were left in the field and many factories had to work without profits.

This Annual consists of three sections. The introductory part is a good compilation of the relevant portions of the various Acts and control rules passed by the Central and the Provincial Governments and also contains a set of 44 useful statistical tables giving all the necessary information about the progress of the sugar industry. The second section is a detailed survey of the vicissitudes the industry has passed through. The next part is the author's own thesis which describes the various problems confronting the industry and gives a detailed discussion of their solution.

This monograph presents a highly informative reading to all those that are interested in the Indian sugar industry.

G. G. R.

RAMANUJAN—HIS LIFE AND WORK

Ramanujan, Twelve Lectures on Subjects Suggested by His Life and Work. By G. H. Hardy. (Cambridge University Press), 1940. Pp. 230. Price 25*sh.* net.

PROF. HARDY, as he rightly claims, is the greatest authority on Ramanujan, and any book by him dealing with the life and work of our illustrious compatriot is bound to be an event of unusual importance in mathematical circles. Prof. Hardy had written a memoir on Ramanujan, which was published along with the latter's collected papers. But it was the general belief that this was not enough from one who saw the departed savant and talked with him almost every day for several years, and who stood in a unique relation to "the most romantic figure in the recent history of mathematics". We are glad to see that Prof. Hardy has tried to supply this long-felt want in the book under review. It originated in two lectures given at Harvard on the occasion of its tercentenary conference in 1936. Since then Prof. Hardy has given many lectures on Ramanujan's work to a number of Universities in England and America, and also regular courses at Princeton and Cambridge.

The first lecture deals with Ramanujan's life and career. Prof. Hardy reaffirms with considerable conviction his earlier opinion of Ramanujan's genius; but he also withdraws one or two statements made in the previous memoir which he now considers quite rediculous sentimentalism. For instance, Prof. Hardy wrote earlier: "He (Ramanujan) would probably have been a greater mathematician if he could have been caught and tamed a little in his youth; he would have discovered more that was new, and that no doubt of greater importance. On the other hand he would have been less of a Ramanujan and more of a European Professor, and the loss might have been greater than the gain." Prof. Hardy refutes this last sentence most strongly, saying that there was no gain at all when the college at Kumbakonam rejected the one great man they had ever possessed, and that the loss was irreparable. This leads him incidentally to pronounce a scathing criticism of our inefficient and inelastic educational system which can fail to recognise the genius of a Ramanujan.

As Prof. Hardy aptly points out, Ramanujan "had been carrying an impossible handicap, a poor and solitary Hindu pitting his brains against the accumulated wisdom of Europe". It should be admitted, however, that in spite of this severe handicap, Ramanujan did beat the accumulated wisdom of Europe in several instances. He was by far the greatest formalist of his time, and one of the three great formalists of all time, the other two being Euler and Jacobi. Prof. Hardy is right when he says: "There have been a good many more important, and I suppose one must say greater, mathematicians than Ramanujan during the last fifty years, but no one who could stand up to him on his own ground. Playing the game of which he knew the rules, he could give any mathematician in the world fifteen."

There are some very good passages in the book which give us a true insight into Ramanujan's character. In one such passage, Prof. Hardy depicts him as a man who, when he was living in Cambridge in good health and comfortable surroundings, was in spite of his oddities, 'as reasonable, as sane and in his way as shrewd a person as any one here'. The picture that the author wants to present to us is "that of a man who had his peculiarities like other distinguished men, but a man in whose society one could take pleasure, with whom one could drink tea and discuss politics or mathematics, the picture in short, not of a wonder from the East or an inspired idiot, or a psychological freak, but of a rational human being who happened to be a great mathematician". Some people may think that having been through a very trying life in the early days, and having achieved world fame almost overnight, Ramanujan might have become somewhat of an egoist. Prof. Hardy dispels this doubt completely by saying that "he (Ramanujan) was not particularly interested in his own history or psychology; he was a mathematician anxious to get on with the job".

In the remaining eleven chapters, Prof. Hardy takes some part of Ramanujan's work as his text, and sets down what occurs to him about its relation to that of earlier and later writers. He has brought out

admirably Ramanujan's originality, his extraordinary power of writing down imposing and generalised formulæ, and also his limitations. The second lecture deals with Ramanujan's work on the theory of primes. As Littlewood has said, every positive integer was one of Ramanujan's personal friends, but in this domain his work was limited by the fact that "he proved next to nothing, and a great deal even of what he imagined was false". Prof. Hardy quotes Littlewood as having said that "the clear-cut idea of what is meant by a proof, he (Ramanujan) perhaps did not possess at all; if a significant piece of reasoning occurred somewhere, and the total mixture of evidence and intuition gave him certainty, he looked no further". But Prof. Hardy admits that Ramanujan found the form of the Prime Number Theorem for himself and that this was a considerable achievement, inasmuch as only very great mathematicians like Legendre, Gauss and Dirichlet could discover it before him.

The third lecture deals with the joint work of Ramanujan and Hardy on the problem of determining the normal degree of compositeness of a number. The fourth lecture gives an analysis of Ramanujan's theorem about the number of numbers between A and X which are either squares or sums of two squares. The other lectures deal with Ramanujan's work on a lattice-point problem, partitions, hypergeometric series, asymptotic theory of partitions, representation of numbers as sums of squares, definite integrals and elliptic and modular functions. In each of these Prof. Hardy has described the genesis of Ramanujan's ideas, his rediscovery of the theorems of other great masters, and his almost uncanny generalisations which are still being tackled and proved by eminent mathematicians. On going through Prof. Hardy's pages we are impressed by one fact above all others, and that is that Ramanujan's is perhaps the only example in the history of mathematics of one man alone providing the life-work of several of his eminent contemporaries.

There is one remark of Prof. Hardy with which it is difficult to agree. Prof. Hardy says: "I very much doubt whether Ramanujan, to the end of his life, ever understood at all clearly what an analytic function is." It should be remembered that Ramanujan stayed at Cambridge for more than three years, and passed the mathematical Tripos. He was dealing with infinite series every day, and as his work on the lattice-point problem shows he was conversant with the idea of a domain. There is nothing very complicated about the analytic function, and there is no reason why Ramanujan should not have grasped either the Cauchy Riemann or the Weierstrassian definition of an analytic function at the first reading. However, if Prof. Hardy's conjecture is true, it does not speak much for the teaching of mathematics at Cambridge, which could not make a Ramanujan understand the nature of an analytic functon at the end of a three years' course. We hardly think that Prof. Hardy himself would like to be forced to this conclusion.

Prof. Hardy has given a historical and explanatory note along with each lecture, and there is a representative bibliography attached at the end of the book. The printing and get-up is all that is expected of a Cambridge University publication.

We are strongly of the opinion that a copy of this book must be in every mathematical library as well as in the hands of everyone who wishes to acquaint himself with the working of the mind of an inspired mathematician who, like Abel and Galois, was snatched away in his prime, and but for whose premature death many chapters in mathematics would have been enriched beyond measure.

M. R. SIDDIQI.

METROLOGY OF PUNCH-MARKED COINS

(1) **A Note on Two Hoards of Punch-marked Coins Found at Taxila** (4 pages).

(2) **On the Study and Metrology of Silver Punch-marked Coins.** By D. D. Kosambi. (*Reprints from New Indian Antiquary*, Vols. 3 and 4.).

IN these two papers Prof. Kosambi makes an excursion into the most intriguing section of ancient Indian numismatics with very happy results. He brings the organon of Statistics to bear on the problems relating to punch-marked coins, and the weights and symbols which seemed to defy all the diligent analysis and classification to which they were subjected by two generations of numismatists bid fair to fall into a more or less intelligible system. The mathematics of it all is beyond the comprehension of the reviewer who is well content to take it on trust from so eminent a mathematician. The conclusions reached by this new method are, some of them at first sight, surprising; they may not receive ready acceptance, and it is possible that further analysis of data and reflection may lead Prof. Kosambi himself to modify them; for as he himself remarks somewhere, 'there is every danger here of guessing too much'. But the easy mastery of the literature on the subject evinced by Prof. Kosambi, and the elegance with which he threads his way through the confusing mass of detail are such as to rouse the reader's admiration and make him wish with all his heart that Prof. Kosambi would make numismatics his second love though tensor analysis may continue to be his first.

While appreciating and making good use of the work of his predecessors in the field, Prof. Kosambi is an unsparing critic of the wrong methods employed by them and their inaccurate reporting of facts. He exposes the hollowness of much pseudo-expertise that has held the field till now, and if he occasionally employs hard phrases, they must be taken to be an index of Prof. Kosambi's reaction to slipshod thinking and lazy arm-chair methods. He draws attention to many inaccuracies in detail in Walsh's *Memoir* on the Taxila hoards—paper (1) above being devoted exclusively to this necessary negative criticism of one of the 'main sources' of the constructive work attempted in the longer paper (2). His estimate of Mr. A. S. Hemmy's statistical work on weights and currency standards is perhaps best conveyed by the sentence: 'If imposing technical terms are to be used to impress archæologists and orientalists, at least the most useful ones should be taken, and an attempt made to use them properly' (p. 15). He rightly grumbles (p. 56) against the lack of co-ordination in the work of the Archæological department seen in the totally different arrangement and notation followed in the two monographs on Punch-marked coins (nos. 59 and 62) issued under the auspices of the department within a few months of each other. He puts in a plea for more accurate and integral recording of the data from each hoard of coins as it is discovered.

In metrology the chief contribution of Prof. Kosambi lies in the opinion he puts forward (p. 13) 'that the *rati* was not used, even in ancient times, to weigh the coins, but rather the coins determined the choice of the seed, exactly as at present'. This, if correct, disposes of many vexed discussions on the *rati*. But it leaves the absolute standard of weight indeterminate, and the tradition of a standard *purana* of 32 *ratis* is a really old one in our country, witness Manu VIII. 136; so that it seems quite natural for numismatists to worry over finding a reconciliation between actual weights of the old coins they handle and the theoretical standard weight. The system of Mohenjo-Daro weights was applied for the earlier Taxila hoard, but in the Mauryan period only in a crude manner (pp. 44-45).

In the interpretation of the punch marks Prof. Kosambi briefly reviews older opinions and methods and makes several suggestions of great practical value. He is not inclined to attach much importance to the persistence of some Mohenjo-Daro symbols among the punch marks on the coins or to ascribe any unduly high antiquity to any of the known coins. He allows for the influence of religious and tantric notions, but on the whole proceeds on the assumption that coinage is a function of the State. He keeps the distinction between obverse and reverse marks clear, and suggests that the reverse marks represent some sort of periodic checking—a suggestion supported by the

remarkably steady drop in average weight particularly for the square coins with the increase in the number of reverse marks (p. 30 and fig. 3). However, "from the fact that an occasional coin with blank reverse occurs in the oldest groups, it is clear that the system of reverse marks applied only to coins in active circulation, and perhaps in a limited region" (p. 31).

The obverse marks have been discussed far more by earlier writers and Prof. Kosambi reviews the numerous suggestions offered and points out several 'neglected possibilities' (p. 11) before stating his own working hypothesis as to the meaning of the symbols. He accepts the crescent-on-arches as the monogram of Chandragupta Maurya, and considers its absence from the earlier hoard a guarantee of its pre-Mauryan character. He isolates a particular variety of the *Sadaracakra* (six-armed symbol) occurring with Chandragupta monogram as the dynastic symbol of Mauryas and suggests that the form of the Cakra should be made the basis of classification by dynasties. The peacock on arches is also Mauryan, and the arches themselves are taken to indicate 'descent from'—at least the five arches. Equally plausible identifications are made of the symbols for Sisunaga, Saisunaga, and Nandin, and those of Mahapadma are reached by elimination.

Prof. Kosambi says more than once that with the establishment of the Mauryan empire we enter on a period of cruder coinage in which 'the variances jump up suddenly', and *prima facie* the condition of the second and later Taxila hoard seems to support this. Yet, this conclusion hardly tallies with impressions of the Mauryan epoch gathered from other sources like the inscriptions of Asoka, or the polished stone pillars—not to speak of Megasthenes and the *Arthasastra*. There are other statements, *obiter dicta*, which may surprise the reader, and even shock him; but there is much, very much in these papers and in their method for which he will be grateful. The work that Prof. Kosambi has been doing is important, and one hopes that the Director-General of Archæology, the museums of the country and individual owners of coin-cabinets will give him all the aid he needs for carrying his researches further. It is a pleasure to see the evidence of his collaboration with Dr. S. Paramasivan of the Madras Museum whom he cites for the phenomenon of decuperification (p. 43) that has not so far been taken note of by numismatists.

K. A. N.

AN AID TO STUDY OF KANT

An Introduction to Kant's Critique of Pure Reason. By N. A. Nikam, M.A. (The Bangalore Printing and Publishing Co., Ltd.), 1941. Pp. 195. Price Rs. 5-8.

Much of the possible criticism having been disarmed or rendered innocuous by the utterances or the *obiter dicta* of the author like "I shall not be dissatisfied if this *Introduction to the Critique of Pure Reason* be described as a partially mistaken help" (Preface), and " If this book cannot claim originality in Kantian scholarship, it can at least claim originality in reversing Kant's order of treatment" (p. 63), I would consider the task of reviewer considerably lightened, though this comment would not certainly mean any disparagement of the excellent work of Prof. Nikam who has made a serious and sustained attempt to push Kant's "Critique of Pure Reason" into the focus of academic awareness and critical consciousness. Helped by a Mysore Government scholarship, he had the "matchless piece of philosophical good fortunes" (viii—I emphatically protest against the typographical plural!!) "in attending the lectures of G. E. Moore and C. D. Broad which kindled and stimulated" his interest in Kant. In *ten* chapters, Prof. Nikam has admirably analysed the contents of the "Critique". Prof. Nikam has easy and perfect control over the subject-matter and I would invite attention of readers particularly to pp. 145–152 in which he sums up the "Central Teaching of Kant's Philosophy", with convincing clarity and intimate insight.

Time was when Indian philosophers were contributing namby-pamby discussions to foreign periodicals on "Kant and Bhagavad-Gita", "Kant and Sankara" and so forth, and I am glad to note that Prof. Nikam has not indulged in blowing the soap-bubbles of pretty, but puerile parallelisms between Kant and Indian idealists like Sankara. But

in a foot-note, he has referred to Advaita in the spelling of which he was caught within the grips of the Printers' Devil. And again "Aham-padartha" is outrageously printed though Advaita has been corrected in "Errata".

Kant's "Critique" has been "made in Germany" with especial emphasis. I wish Prof. Nikam had not echoed or re-echoed the familiar critical judgments on Kant. It will not be an exaggeration to state that a real and genuine estimate of Kant has yet to be attempted by Western philosophers themselves. Whether at all Kant ever woke up from the dogmatic slumber from which he claims to have been rudely awakened by Hume, and whether at all he has effected any Copernican revolution in philosophical outlook are some of the persistent problems of Kantian *Weltanschaung,* and though as Prof. Nikam points out (p. 21) Kant himself might not have urged or adumbrated such a claim, critics have a duty to examine the claim that the most striking contribution of Kant is transference of philosophical emphasis from the objective to the subjective. Prof. Nikam does not examine the claim in any detail.

The fact is that on the plea of an analysis of the conditions and characteristics of *a priori synthetic judgments,* Kant has really constructed an elaborate and imposing *totalitarian structure in philosophy.* Surprise, bewilderment, astonishment and admiration which have marked reaction to Kant's work are all due to the psychological dread of the unknown and the ununderstood. There are many who are likewise scared away by the style of Sankara. In the Kantian scheme of *Totalitarian Metaphysics* the objective reality was assigned some sort of existential recognition in a patronising manner and it is this totalitarian scheme that supplied the motive-force of the subsequent totalitarian metaphysics of Nietszche who advocated the cult of the *Ubermensch,* master-morality, slave-morality and the like. In Hitler's campaigns against Democracy and against all weaker nations, one witnesses directly the practice of the totalitarian philosophy of Kant and Nietszche. Psycho-analysis of the Freudian brand was perfected in Germany, and there is no use fighting shy of the same psycho-analytic technique being applied to an analysis of the metaphysical mind of Kant as revealed in his "Critique".

Be that as it may, Prof. Nikam seems to view the work of Prof. Paton almost with religious awe and fervour as if biblical sacrosanctity attached to it! Prof. Paton has to be rated as an enthusiastic admirer of Kant, and like all admirers he naturally seeks to make much of Kant and his work. Paton's estimate of Kant is not after all altogether a philosophically detached one.

It is noteworthy that a citation from Omar Khayyam stands at the opening of each chapter. Prof. Nikam should therefore not blame the reviewer if he closed with the observation that after a fairly careful study of the work of Prof. Nikam, the reviewer was obliged to come out of the edifice or structure of the Kantian metaphysics by the same door as in he went!! Still, I heartily commend Prof. Nikam's neat little volume on Kant as an eminently suitable text-book for university students of the philosopher of Konisberg.

R. NAGA RAJA SARMA.

CENTENARIES

Baskerville, Simon (1574–1641)

SIR SIMON BASKERVILLE, a British physician, was born at Exeter October 27, 1574. He joined the Exeter College, Oxford, in 1591 and was elected a fellow even before he graduated. He became M.B. in 1611 and after some practice entered the College of Physicians, London, in 1614 and became a fellow thereof in 1615.

Even when Baskerville was an undergraduate his brilliance was such that when James I visited the University, he was "chosen as a prime person to dispute before him in the philosophic art, which he performed with great applause of his majesty". In later years when he rose to eminence as a doctor, he was appointed physician to James I and later to Charles I who knighted him in 1636.

Baskerville had such wide practice and thereby amassed so much wealth that he came to be known as "Sir Simon Baskerville the rich". He was also generous. 'He never took a fee of an orthodox minister under a dean nor of any suffering cavalier in the cause of Charles I .... but with physick to their bodies generally gave relief to their necessities".

Baskerville died July 5, 1641.

S. R. RANGANATHAN.

University Library,
Triplicane.

SCIENCE NOTES AND NEWS

Leguminous Plants and Their Root-Nodule Bacteria.—The view that a leguminous plant will symbiose with only one or closely related strains out of the many strains of the nodule-forming organisms that may exist in the soil and that the division of these organisms into several distinct (some twenty in number at present) plant-bacteria groups based upon that view, have formed the subject of a very elaborate examination and conclusions very much at variance with this view have been arrived at as the result (J. K. Wilson, *Memoir* 221, Cornell University Agr. Exp. Stn.). About 200 species of plants representing more than 70 genera, and 32 strains of the rhizobia isolated from a wide range of plants were used in the work, and each species was exposed during its growing period to each strain. After a suitable period of growth the roots were examined for nodules, the presence of which was taken as the criterion of symbiosis. It was found that a number of plants were promiscuous and will symbiose, as measured by the nodulation, with almost any strain of nodule bacteria with which their roots may come into contact. Conversely, certain strains of bacteria isolated from various different plants will symbiose with species of plants that represent a large majority of the plant-bacteria groups. Plants were also grown with their root systems divided and allowed to grow with each division in a separate soil medium with a different strain of bacteria; they symbiosed in all these different media and showed that a plant could simultaneously symbiose with several strains. It however appears from the plates which illustrate the paper that nodule formation is not equally plentiful or striking in all the different strains with which a plant can symbiose. While many plants can symbiose with several strains of rhizobia there were others which were somewhat restricted as to the number of strains they could symbiose with. Another conclusion reached is that these plants that are promiscuous will symbiose with strains that are predominantly monotrichic and predominantly multitrichic, while those which are restricted symbolise with strains that are predominantly monotrichic. A. K. Y.

Cardamom Weevil and Its Control.—Further work on the cardamom weevil (*Prodiocts hœmaticus*) has been carried out by Mr. S. Jones, M.Sc., Assistant Entomologist, Central Research Institute, Trivandrum.

There are evidences of the weevil proving to be a major pest of potential danger to cardamom cultivation in S. India, specially in Travancore.

The weevil, a brown, spotted insect, lays its eggs on the rhizomes, the grubs that hatch out boring into them and later into the shoots. The external symptoms become evident only after the attack has well advanced.

A promising method of eradication of the pest, has suggested itself and it consists of rooting out and burning the diseased clumps and picking of the adult weevils, when they appear in fairly large numbers and rest on the cardamom plants, from the second week of April, presumably for mating.

The Lady Linlithgow Tuberculosis Sanatorium, Kasauli.—Her Excellency the Marchioness of Linlithgow, the President of the Tuberculosis Association of India, performed the Opening Ceremony of this all-India institution on the 21st of May 1941, in the presence of a distinguished gathering. This sanatorium will have accommodation for 112 beds to begin with, which, it is hoped, in course of time will be increased to 250 beds.

In the course of her speech Her Excellency said: "It is necessary to emphasise that the greatest difficulty in the tuberculosis campaign in India is not, as generally supposed, lack of money, but the lack of a sufficient number of doctors properly trained in modern methods of diagnosis and treatment. It is a hopeless task to try and fight tuberculosis in India without having doctors who have specialised not only in diagnosis and treatment but also in the prevention of the disease and in the care and after-care of the tubercular patient. The difficulty facing us is not the lack of doctors willing to take up special training, but that there are in India too few places where all the facilities exist for the proper training of such doctors. This training requires at least nine months' residence in a fully equipped modern sanatorium, such as this one, where doctors can gain experience in the wards, in the operating theatre, the X-ray and the laboratory. Research work will also be carried out there, without which no teaching institution can be complete. By research I don't mean only bacteriological research, but research necessary with regard to the development of the disease and the various treatments.

While bacteriological research can be carried out in a comparatively small institution, the other kind of research can only be effectively carried out in a sanatorium or hospital with a large number of patients."

Basic Steel from Scrap.—Steel made by the acid process from 100 per cent. scrap is now being manufactured in India. It is anticipated that this will relieve the shortage of spring steel required by the Railways which had hitherto been imported.

Arrangements are also being made for the erection of open hearth furnaces for making basic steel from scrap collected from all over India.

Further, experiments are in hand for utilizing the large quantities of turnings and borings produced in shell manufacture. Previously these had always been looked upon as a waste

product, but they will now be turned into new steel.

Industrial Research Council.—Details are now available of the action taken by the Government of India on certain recommendations of the fifth session of the Industrial Research Council.

As the need of a clearing house of information regarding industrial research was generally felt, the Council had recommended that the Industrial Research Bureau might undertake this work and also circulate periodically information as to researches and investigations in progress in India in order to enable researchers on the same or allied subjects to exchange information. This is being arranged for under the auspices of the Board of Scientific and Industrial Research.

The recommendation of the Council that the Director of Industrial Research Bureau be requested to prepare and circulate, after consultation with Directors of Industries and others concerned, a draft questionnaire to assist in any survey of the tanning industry and to draw up and circulate an outline of a scheme on which the survey of the tanning industry should be conducted, will be referred to the Director of Scientific and Industrial Research for consideration and proposals.

The Council had also recommended further enquiries regarding utilisation of milk casein for the manufacture of plastics, investigation of the production of acetic acid, acetone and related compounds for the viscose process of artificial silk manufacture, the manufacture of synthetic resin of the bakelite type, the possibility of manufacturing formaldehyde and urea, investigation of the available sulphur-bearing deposits in India, utilisation of linseed straw for the production of cottonous flax, and the more efficient utilisation of coal. These recommendations will be borne in mind by the Research Committee of the Board of Scientific and Industrial Research. Large deposits of sulphur have already been discovered by the Geological Survey of India in Baluchistan and elsewhere.

Archaeological Survey Reports.—An index covering the series of annual reports of the Archæological Survey of India from 1919 to 1929 and the first part of the reports from 1902 to 1918 has been issued. The work has been done by Mr. H. Hargreaves, formerly Director-General of Archæology, and enables the entire material published in the reports of the Archæological Department to be referred to with facility. An index of Part II of the reports for the years 1902 to 1916, prepared by the late Mr. G. R. Kayes, was issued some years ago.

Andhra University — Two Events.—The Andhra University has recently inaugurated the Natural Science Department under distinguished auspices. Without this complement the organization would be lopsided and even artificial. We hope that under the stimulating influence of the distinguished Vice-Chancellor this new academic recruit will acquire sufficient energy in the field of teaching and research, which will place it on a level with the older branches of science. From the standpoint of exploration and investigation the Andhra Desa is sufficiently rich and varied in its biological resources which offer practically an unlimited scale of activities to the research workers. With a well regulated scheme of co-ordination among the different branches of the Department the Andhra University will be able soon to establish schools of biological teaching and research. It would be premature to discuss the organisation of departments of applied biology—but its consideration need not be unduly delayed because of the decided advantages offered by the flourishing departments of chemical technology and organic chemistry.

Another equally interesting and important institution known as Faculty Club was formally inaugurated. One of the inescapable consequences of our being men is that we have a stomach on whose shape and condition depends the peace of the world as well as the progress of knowledge. Worked in conjunction with the class room efforts and the laboratory practice we anticipate that the Club will exercise a soothing and generous influence in promoting the cheerful and healthy temperament of the University. The institution of a Faculty Club is calculated to dispel dyspepsia, melancholia, neurasthenia and other mental ailments peculiar to the teaching profession and the coming into being of common messmatism in the University Halls will inspire a new spirit of comradeship and co-operative effort among the members of the staff. Now all that the scholars have to do is to read their books and keep their bowels open to receive the blessings of this new dispensation.

ASTRONOMICAL NOTES

Planets during August 1941.—Venus will be an evening star and continues to separate slowly from the Sun; although not quite favourably placed for observation, it will be a fairly bright object in the western sky, setting about two hours after the sun. Mercury is in the morning sky for the first half of the month, but being too near the sun will not be easily visible; it passes superior conjunction on August 19. Mars rises about three hours after sunset and can be seen during the remaining portion of the night as a brilliant red star of magnitude $-1{\cdot}3$; it is moving rapidly eastward along the southern border of the constellation Pisces. The planet is getting nearer the earth, the apparent diameter increasing from $15''{\cdot}0$ to $19''{\cdot}4$ during the month.

Saturn rises at about midnight and Jupiter an hour later; and both can be conveniently observed near the meridian a little before sunrise. Jupiter is increasing in brightness, its stellar magnitude at the end of the month being $-1{\cdot}8$ (a fifth of a magnitude brighter than Sirius). Saturn also is getting brighter and the ring system continues to widen. The planet will be in quadrature with the Sun on August 21. Uranus is in Taurus and three to four degrees to the northeast of Saturn.

Neptune is in the evening sky and is situated very near (about half a degree north) the star β Virginis—magnitude 3·8. A close conjunction of the planet with Venus will take place on the evening of August 18, which will be helpful to observers with small telescopes, in locating Neptune.

The Perseids.—One of the most interesting of the meteoric showers is that known as the Perseids whose maximum display may be expected to occur about August 12. The radiant point is in the constellation Perseus and the position is given by R.A. 3^h 8^m and Declination 57° N. (four degrees to the north of the bright star γ Persei). The duration of the shower is about 25 days and the average number of meteors that can be seen per hour is 50.

T. P. B.

MAGNETIC NOTES

The month of May, 1941, was magnetically more active than the preceding month. There were 5 quiet days, 22 days of slight disturbance and 4 of moderate disturbance as against 9 quiet, 20 slightly disturbed and 2 moderately disturbed days during May 1940. The characters of individual days are given in the following table:—

Quiet days	Disturbed days	
	Slight	Moderate
2, 19, 26, 28 & 29	1, 3-5, 7-16, 18, 20, 22, 23, 25, 27, 30 & 31	6, 17, 21 & 24

The most quiet day in May 1941, was the 19th and the most disturbed, the 21st. One moderate storm was recorded during the month as in May, 1940. The mean character figure for the month was 0·97 as against 0·77 for May 1940.

The month of June 1941, was more active magnetically than any of the preceding months in the year. There were 22 slightly disturbed and 8 moderately disturbed days as against 9 quiet days, 19 days of slight disturbance and one day each of moderate and great disturbance in June 1940. The most disturbed day in the month was the 13th when a magnetic storm of moderate intensity was recorded. The least disturbed day in the month was the 16th. There were no quiet days in the month. The characters for individual days are given below:

Quiet	Di turbed days	
	Slight	Moderate
..	1-8, 11, 12, 16-26 & 28.	9, 10, 13-15, 27, 29 & 30.

Three magnetic storms of moderate intensity were recorded during the month as against one of great intensity in June 1940. The mean character figure for June 1941 was 1·27 as against 0·77 for June 1940.

SEISMOLOGICAL NOTES

During the month of June 1941, one very great, three moderate and three slight earthquake shocks were recorded by the Colaba seismographs as against one moderate and one slight shock recorded during the same month in 1940. Details for June 1941, are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
		H.	M.	(Miles)		(Miles)	
June 1941—							
24	Moderate	14	58	3430	38°·7 N., 18°·8 E., in the Ionian Sea		
26	Very Great	17	22	1470	In the neighbourhood of the Nicobar Islands		
27	Slight	13	03	1450			After shocks of the very great shock of 26th.
27	Moderate	14	02	1490			
28	Slight	00	34	1520			
28	Slight	23	25	1520			
30	Moderate	23	54	1420	13°·5 N., 93°·7 E., In the neighbourhood of the North Andaman		

ANNOUNCEMENTS

Indian Science Congress Association (*Twenty-ninth Session*).—The General Secretaries of the Indian Science Congress Association, Professor S. K. Mitra and Principal P. Parija, have released the following information in connection with the Twenty-ninth Session of the Indian Science Congress to be held from the 2nd to the 8th January 1942:

The Session was originally proposed to be held at Dacca, but the University of Dacca, under whose auspices the Session was to have been held, having recently decided otherwise, the Congress Session will be held at Baroda in response to the kind invitation of His Highness the Maharaja Saheb. Principal K. G. Naik of Baroda College has been requested by the Baroda Government to start with the necessary arrangements.

Mr. D. N. Wadia, M.A., B.SC., F.G.S., F.R.G.S., F.R.A.S.B., F.N.I., Mineralogist, Ceylon Government, Colombo, will be the President.

Application forms for Ordinary and Sessional Membership for the Congress may be obtained from the Office of the Association, 92, Upper Circular Road, Calcutta.

Papers proposed to be read should be forwarded to the General Secretary together with three copies of abstracts so as to reach him not later than September 15, 1941.

The enrolment of the *Ordinary Members* will be closed after the 15th of July 1941. Only Sessional Members will be enrolled after that date.

Intending members are requested to send their subscriptions to the Treasurer, Indian Science Congress Association, 92, Upper Circular Road, Calcutta.

Flora of the Punjab Plains.—Since the publication of the note in *Current Science* (May 1941), Dr. Sabnis, the author of the pamphlet has informed us, that he proposes to issue further contributions on the Flora of the Punjab Plains and the Associated Hill regions to include the remaining natural orders. The publication that has appeared is to be regarded as the first in the series.

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4580, 4583 and 4585.

"Journal of Agricultural Research," Vol. 61, No. 12 and Vol. 62, Nos. 1-3.

"Indian Journal of Agricultural Science," Vol. 11, Pt. II.

"The Nagpur Agricultural College Magazine," Vol. 15, No. 4.

"Journal of Chemical Physics," Vol. 9, No. 5.

"Chemical Products and Chemical News," Vol. 4, Nos. 5-6.

"Experiment Station Record," Vol. 84, Nos. 4 and 5.

"Allahabad Farmer," Vol. 15, No. 3.

"Transactions of the Faraday Society," Vol. 37, Pt. 3.

"Indian Farming," Vol. 2, No. 6.

"Genetics," Vol. 26, No. 3.

"Review of Applied Mycology," Vol. 20, Parts 3-4.

"The Mathematics Student," Vol. 8, No. 4, and Vol. 9, No. 1.

"The Bulletin of the American Meteorological Society," Vol. 22, Nos. 3-4.

"Journal of the Indian Mathematical Society," Vol. 5, No. 1.

"The Indian Medical Gazette," Vol. 76, No. 6.

"Journal of Nutrition," Vol. 20, Nos. 3 and 5.

"Journal of the American Museum of Natural History," Vol. 47, No. 4.

"Nature," Vol. 147, Nos. 3719, 3725, 3728, 3729 and 3730.

"Journal of Research" (National Bureau of Standards), Vol. 26, No. 4.

"Canadian Journal of Research," Vol. 18, No. 12 and Vol. 19, No. 3.

"Sky," Vol. 5, No. 7.

"Science and Culture," Vol. 7, No. 1.

"The Indian Trade Journal," Vol. 141, Nos. 1825-28.

Books

"Recent Advances in Sex and Reproductive Physiology," by J. M. Robson. (Messrs. J. A. Churchill, Ltd.), 1940. Pp. xii + 329. Price 15*sh.* net.

"The Birth and Death of the Sun," by George Gamav. (Macmillan & Co.), 1941. Pp. xiv + 232. Price 12*sh.* 6*d.* net.

"The Bombay Karnataka"—A Geographical Survey, by B. S. Sheshgiri. 1941. Pp. i + 208. Price Rs. 2.

"The Air and Its Mysteries," by C. M. Botley. (The Scientific Book Club, London), 1940. Pp. 1 + 266. Price 2*sh.* 6*d.*

"The Annual Review of Physiology," edited by James Murray Luck. (The American Physiological Society and Annual Reviews Inc.), 1941. Pp. viii + 784. Price $5·00.

"The Social Life of Animals," by W. C. Allee. (The Scientific Book Club, London), 1941. Pp. xiv +261. Price 2*sh.* 6*d.*

"General Bacteriology," by D. B. Swingle. (Chapman & Hall, London), 1941. Pp. xii + 313. Price 16*sh.*

"Aircraft Engines," Vol. II, by A. W. Judge. (Chapman & Hall, London), 1941. Pp. viii + 446. Price 30*sh.*

"Electrodynamics," by Leigh Page and Norman Ilsley Adams (Jr.). (Chapman & Hall, London), 1941. Pp. xii + 506.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences:

June 1941. SECTION A.—R. V. SUBRAHMANIAN: *The spectral character of the reflection by a regularly stratified medium: Part I.* For a given number of plates, the bands are more sharply defined for smaller values of the reflecting power, though the intensity of the reflected light is smaller. Some secondary bands begin to appear on the shorter wavelength side, when the reflecting power is sufficiently large. P. G. N. NAYAR: *Luminescence, absorption and scattering of light in diamonds: Part I. Fluorescence.* The spectrum is found to consist of a sharp band at 4156 Å, followed by a set of discrete but rather diffuse bands at 4278, 4387, 4514 and 4643 Å. The effect of temperature on the bands has been studied from $-180°$ to $200°$ C. The fluorescence disappears at higher temperatures, the band at 4156 falling off in intensity at a more rapid rate than the other bands. K. R. DIXIT: *Effect of admixture of silver on the rectifying properties of Cu-Cu_2O cells.* The rectification is maximum for 7½% Ag when temperature of formation of layer is 800° C. R. R. BAJPAI AND V. I. VAIDHIANATHAN: *On the preparation of quartz ultrasonic oscillators.* L. RAMACHANDRA ROW AND T. R. SESHADRI: *Pyrilium salts derived from 4-O-methyl resorcylic aldehyde.* HANSRAJ GUPTA: *Some idiosyncratic numbers of Ramanujan.* N. A. SHASTRI: *Some relations between Bessel functions of third order and confluent hypergeometric functions.* S. S. PILLAI: *On the sum of functions connected with primitive roots.* S. S. PILLAI: *On M consecutive integers—III.* P. G. N. NAYAR: *Luminescence, absorption and scattering of light in diamonds: Part II. Phosphorescence.* True fluorescence lasting for less than 10^{-4} seconds consists of the region of discrete bands alone. The phosphorescence takes a time of the order of a minute, for its full excitation, and several minutes for its decay. S. BHAGAVANTAM: *Raman effect in relation to crystal structure: Lattice oscillations.* P. BHASKARA RAMA MURTI: *Paper pulp from annual crops. Part II. A note on the yields and characteristics of pulps from different varieties of rice straw.* S. RAJAGOPALAN: *Synthetical experiments in the group of sympathomimetics. Part II. Poly- and hetero-cyclic ring systems.*

SECTION B.—M. DAMODARAN AND T. R. VENKATESAN: *Amide synthesis in plants. I. The succinoxidase system in plants.* KANHAIYALAL MATHUR AND REAYAT KHAN: *The development of the embryo sac in* Vogelia indica, *Lamk.* B. L. KAW: *Studies on the Helminth parasites of Kashmir. Part I. Description of some new species of the genus,* Pomphorhynchus *Monticelli* (1905). MISS C. K. RATHNAVATHY: *The spermatogenesis of* Clibanarius olivaceous, *Henderson.*

Royal Asiatic Society of Bengal:

July 7, 1941.—*Tibetan and Bhotia blood group distributions:* At an ordinary monthly meeting of the Royal Asiatic Society of Bengal, Dr. Eileen W. E. Macfarlane presented a paper on the Tibetan Bhotia blood group distribution.

One hundred and twelve mixed Bhutias were grouped at Darjeeling, North Bengal. They showed less of Group B than of Group A and over 10 per cent. of Group AB. When those born in Tibet were separated from those born in Sikkim or Bengal the former were found to be genetically in equilibrium and the latter to be racially mixed. The Bhotias of Sikkim are known to have interbred with the Lepchas. They show three times as much of Group AB as the Tibetans, and this increase is at the expense of Group A. The blood group distribution in mixed Bhotias is of the same order as that found in the Khasis of Assam. A small sample of bloods was typed and indicates that Type N is scarce among the Bhotias and that the types are distributed as among the Bengalis.

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THE STANDARDISATION OF DRUGS AND CHEMICALS

MEDICINE is closely meshed with the gears of our social and economic organization, and the problem of public health is bound up as much with the skill and efficiency of medical care, as with the purity and strength of the drugs employed by the profession in alleviating human suffering. In 1930 the Government of India appointed the Drugs Enquiry Committee under the chairmanship of Sir Ram Nath Chopra to investigate the question of adulterated and low standard drugs freely offered for sale, and to submit recommendations for combating the menace to public health, and for controlling the ethical drug trade and the scientific medical practice in India. After a comprehensive examination of the whole problem in all its various aspects, the Committee emphasised the need for the enactment of a measure by the Central Legislature for the control of the importation, manufacture, sale and distribution of adulterated and substandard drugs, and secondly for the establishment of a machinery for the systematic collection and testing of drugs to secure conformity to proper standards of purity and strength. On the basis of these recommendations The

Indian Drugs Act was passed in 1940, and the nucleus of a Central Laboratory (which later was developed into Bio-chemical Standardisation Laboratory) was founded in 1937 as an adjunct to the All-India Institute of Hygiene and Public Health in Calcutta. The Laboratory which has grown from small beginnings, is now fairly satisfactorily equipped for research work of a high character in the science and art of preparing drugs, and is provided with a Bio-assay Section for acute and many chronic experiments in connection with hormones and vitamins.

Perhaps the most interesting section of the Laboratory is the Drug Museum, which is to function as a reference centre, and where various types of pharmaceuticals and biological products which are commonly found adulterated, understrength or misbranded in the open market, either as a result of wilful adulteration or subterfuge or as storage deterioration, will be properly displayed.

The triennial report of the Laboratory just issued is an impressive document, recording achievements during the period of 1937–40 whose significance will be of the highest importance, not only as a measure of fulfilment of the chief functions outlined by the Central Drugs Laboratory, but also as a means for a better organisation of public health work. In the initial stages, the work of the Laboratory was mainly confined to routine analytical work of certain definite drugs of comparatively greater importance, and attention was accordingly concentrated on surveying the quality of Tincture Digitalis, Tincture Strophanthus, Tincture Scilla, Posterior Pituitary Extract, and Adrenaline Hydrochloride Solution, including among these a few samples of insulin, organic antimony, and arsenic compounds and sulphonamide preparations. This survey has shown that out of a total of 1,044 samples of pharmacopœial preparations, nearly 480 or 46 per cent. do not satisfy the standards laid down. "There cannot therefore be any doubt about the seriousness of the situation regarding the drug adulteration existing in this country." Analysis of other pharmacopœial drugs, those mentioned in the British Pharmaceutical Codex 1934, patent, proprietary and miscellaneous remedies and Hospital mixtures and solutions revealed that a very large percentage fell below the specifications claimed by the manufacturers and dispensing agents. Though the results of investigation may bring to light the poor quality of medicines ordinarily supplied to the people, yet they prove that the constitution of the patients is of the appropriate standard. Perhaps a more alarming picture would have been presented, if proper arrangements had been made for the checking of imports, policing of manufacturing houses and frequently inspecting the retail dealers' stores. With the enforcement of the Drugs Act, perhaps a more wide-spread and constant vigilance is now possible.

The Laboratory has a very comprehensive routine work, the functions including the assaying and testing of chemicals, drugs, biological products and organometallic compounds, standardisation of methods of analysis and tests with due regard to the climatic and other conditions prevailing in different parts of India, in addition to undertaking tests of commercial drugs for manufacturers and dealers, preparation and maintenance of stable standards of strength,

purity and quality of drugs. The Laboratory acts as a "National" distributing centre for International standards, aside from acting as an expert referee in respect of disputed analysis. Important as this work must be in guaranteeing the appropriate specifications of important remedies for general use, the Laboratory influence as a scientific centre will be exerted in the field of researches on pharmacological testing of drugs, in guiding and co-ordinating the work of the Provincial Government laboratories, and in serving as the training ground for "public analysts" in the methods of chemical, biochemical and biological assay. With the object of warning non-ethical and fraudulent manufacturers and distributors in India, and also with the object of creating a consciousness amongst the consuming public of the importance of the problem of drug adulteration from the public health point of view, the Laboratory has carried out propaganda by the publication of informative articles and through press circulars.

The excellent and far-reaching results obtained by the Laboratory must find a wider application than merely an appreciation of the quality of drugs, for the imposing array of facts and enlightening figures must have a deeper significance in relation to a better organization of medical care. The needs of a vast population of a country like India cannot be estimated by doctors alone; the problem is to be investigated by social scientists, economists and government administrators. What emerges as a result of scientific comparative study of all the possibilities of improvement should form the basis of a comprehensive policy of reorganization of public health administration. We have hardly an adequate conception of what constitutes a proper medical care and insurance of public health, for the problem transcends the scope of medical relief. We have to deal not only with the medical and scientific problems relating to drugs, but also, with the social and economic problems as well, and unless these two aspects of the insides of family situations and of homes are thoroughly understood, the efforts of laboratory standardisation of drugs alone can afford but a partial alleviation.

It is impossible to read the Report profitably unless it is borne in mind that the aims and purposes of the Laboratory traverse beyond the strictly scientific or professional angle, and we are convinced that the intent of the manifold investigations is to prove in order to improve human existence. We are poignantly aware that the human problem is of subtle composition, capable of being solved not by laboratory experiments only but by investigations guided by all the resources of science and statesmanship. Of outstanding interest to us in the whole report is the fact that medical scientists will find in the results of investigations conducted in the Laboratory, new fields for organizing medical care and for planning for the health of the population and for the formulation of proposals for advancing medical science, raising standards of medical practice and for improving medical education.

LADY TATA MEMORIAL TRUST

IN 1932 the late Sir Dorab J. Tata created a Trust to perpetuate the memory of the late Lady Tata and set apart a sum of Rs. 25,00,000 from whose income four-fifths was earmarked for promoting investigation of blood diseases with special reference to leukæmia to which the late Lady Tata fell a victim in 1931. This amount was to be devoted for international awards made by a Scientific Advisory Committee operating in London. The remainder one-fifth was reserved for the benefit of the Indian workers engaged in investigations of problems connected with the relief of human suffering caused by diseases. The value of each international scholarship was fixed at £400 per annum, and the corresponding emolument for the Indian scholars was Rs. 150 per month.

During the eight years in which the endowment has been operating, about 50 scholarships were awarded, and, including renewals, about 28 scholars have been working at different scientific institutions. Roughly India has benefited to the extent of Rs. 78,000 and has produced about 148 papers. This gives an average of 18·5 papers per year and 5·2 per scholar. It has cost the Trust about Rs. 527, an amount equivalent to scholarships for 3½ months to enable an Indian scholar to produce a paper. Virtually this amount represents the scholarship drawn each month by an international beneficiary. We have no idea of the amount expended towards maintaining the international scholars, the institutions where investigations have been conducted and the total output of papers.

The endowment is a magnificent one. India is deeply indebted to the Tata family for the creation of numerous trusts for the benefit of her young men, who, after a brilliant career in the universities, seek for opportunities to prosecute post-graduate work. With the limited funds at the disposal of the universities, they manage to maintain a certain number of scholars in their departments, and as the Lady Tata Memorial Trust has recently reduced the number of admissions, the overflow from the universities now runs into waste. The asset of a country is measured by its output of work, and where young men's energy is diverted into unproductive professions, which might offer the most glittering prizes of life, without being utilized for the enrichment of the people, the country must remain backward and poor. The material resources of India are proverbially rich, and it is the hand of science that can gather the harvest. If under any circumstances science is permitted to be neglected and starved, the country will take a long time to recover from the consequences of such an unwise and imprudent policy. The universities and the existing scientific institutions have to be expanded and provided with adequate funds, and science, as a career for young men of promise, should be made to offer them sufficient attraction. Among the post-war problems which will soon confront the statesmen of India, none will be more serious and urgent than the problem of young men, able and willing to do work but finding none. Science and industries may offer a solution.

THE WHEAT RUST PROBLEM OF INDIA

BY
K. C. MEHTA
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INDIA is one of the prominent wheat-growing countries of the world and the largest producer of that commodity in the British Empire yet, with the exception of a temporary revival at present, she has been steadily losing her position in the international market. Considering the fact that on an average there are 34 million acres under wheat each year, a yield of less than 10 million tons is exceedingly poor. This is largely due to the fact that nearly 80 per cent. of the area is covered by the inferior quality, indigenous (*dési*) varieties. Inadequate manuring, absence of irrigation and the frequent failure of winter rains over large tracts are the other obvious causes of poor yield. In addition, rusts are responsible, year after year, for a colossal damage to the wheat crop.

In view of the rapid increase in the population of this country, as revealed by the recent census, there is danger of a serious shortage in the supply of wheat even for home consumption in the near future. It is necessary, therefore, to stress the need of a fuller understanding of the problem under review so that efforts be made, at an early date, to obtain a much higher yield from the same area by mitigating, as much as possible, the huge loss that is caused by rusts at present.

Unfortunately, in the greater part of the wheat area, all the three rusts, black, brown and yellow, are fairly common. Yellow and black rusts also attack barley, which covers an acreage of 8–9 millions per year in this country.

Rusts of wheat are caused by three different species of a parasitic fungus belonging to the genus *Puccinia*. Each rust spreads from plant to plant by microscopic germs (spores) that are blown by wind. Under favourable conditions of weather, a single spore may give rise, within 7–10 days from the time it alights on a wheat plant, to several blisters (pustules) containing hundreds of fresh spores. That explains how, from an handful of diseased plants in a field, a serious epidemic might be caused within 4–6 weeks, if conditions of weather happen to be favourable for the spread of rust.

For a review of contemporary work carried out in North America, Europe, Australia and elsewhere as well as for fuller information on different aspects of the wheat rust problem of this country, reference may kindly be made to the various contributions by the writer.[1–6] In the present article, for want of space, only a brief summary of the more important results is given.

Sources of Annual Recurrence

Butler[8] stated that *Berberis*, the well-known alternate host of black rust in temperate countries, may be left out of account in India. Butler and Hayman[10] found that after five minutes' exposure at 45° C. or on exposure to the sun for a few hours when the shade temperature was 95° F., uredospores (the winter stage) of yellow rust lost all viability. These authors concluded that in the plains of India infection from the previous crop was extremely unlikely. Burns (1909, work unpublished) concluded, from inoculation experiments carried out under the shade of a mango tree during May at Poona (1850 ft. a.s.l.), that given a series of wheat plants, two or almost three generations should secure the continuance of black rust from season to season in the uredo-stage. Later, Butler[9] stated that teleutospores (the summer stage in this country) of black rust have lost their power of germination in the plains and that it is doubtful if the barberries carry the race of the parasite, which is found on wheat, even in the hills. He concluded that no satisfactory answer could be given to the question as to how rusts tide over the unfavourable season when they have no wheat to feed on.

That raised the fundamental question as to where lies the source? The present state of our knowledge regarding the fresh infection of wheat by each of the three rusts, from year to year, is summarized below:—

(1) Fortunately, *Berberis vulgaris* Linn. and *Thalictrum flavum*, the two most susceptible species of alternate hosts of black and brown rusts respectively, do not occur in India and so far no alternate host

has been discovered anywhere for yellow rust.

Germination of teleutospores of black and brown rusts was obtained, in this country for the first time, during the course of recent studies and a large number of inoculations were made on their alternate hosts.

(2) *B. lycium* and only seedlings of two other indigenous species have been found to be moderately susceptible to black rust. Similarly, two indigenous species of *Thalictrum* have shown moderate susceptibility to brown but there is no case on record, nor could any evidence be obtained during recent studies, of an outbreak of either of these rusts starting from its infected host in nature. In India, barberries and *Thalictrum* grow only in the hills.

(3) On the other hand, black and brown rusts have been found to break out, year after year, at several places in the plains as early as December-January, *i.e.*, 3–4 months prior to the period of the earliest possible infection of their alternate hosts in the hills.

(4) Recent studies have clearly shown that the alternate hosts, referred to above, play little part in the annual recurrence of black and brown rusts, at any rate, as far as the plains are concerned.

In view of the scarcity of viable teleutospores even in the greater part of the wheat area in the hills and the general dryness of weather during spring, infection of barberries and *Thalictrum* is more likely at higher altitudes (nearly 7,000–9,000 ft. a.s.l.) during the monsoon, June–August but this should be of little consequence to the crops which are ready for harvest by the end of June practically all over the hills.

(5) On account of the intense heat of summer that follows the harvest, it is almost impossible for uredospores of any of the rusts of wheat to survive in the plains and consequently there is no local source of infection at the time of the next sowing.

(6) Uredospores of all the three rusts, two of which as stated above also attack barley, have however been repeatedly found to oversummer on self-sown plants and ratoon tillers of wheat and barley in the hills because of milder weather. At Simla (nearly 7,000 ft. a.s.l.) all these rusts have been found to oversummer as well as overwinter in miniature plots during the last 10 years.

(7) Several times, fresh outbreaks of rusts have been observed in the hills after 4–6 weeks of sowing of the new crop, within a few feet of rusted stray plants of wheat and there is plenty of uredo-material, at altitudes suitable for each rust, at the time of new sowings. Black rust of wheat has also been found simultaneously on some wild grasses but no evidence could be obtained of its propagation, from season to season, on any of them.

(8) Well-advanced infection of *early* crops in some of the hills has also been found long before rust outbreaks in the neighbouring plains. In general, rusts have been observed to appear much earlier and plant for plant there is heavier infection at foot-hills than at places farther off in the plains.

(9) Wheat sown 'out of season', at some of the foot-hill stations at writer's request, got infected as early as September–October, 2–4 weeks before the normal period of sowings in the neighbouring plains.

It is clear that all the three rusts of wheat are largely propagated by uredospores in the hills, from season to season. The rôle of uredospores in the annual recurrence of rusts, therefore, is a factor of outstanding importance and far more potent than that of alternate hosts.

Dissemination in Relation to Initial Outbreaks

In the plains of India, initial outbreaks of rusts are delayed by 2–3, sometimes 3–4 months from the time of sowings, whereas wheat inoculated several times, with uredo-material of black and brown rusts brought down from the hills during October-November, in a cage at Agra, which is one of the warmer places, got infected in 7–8 days. In the case of yellow rust, which thrives in cool weather, infection took place only towards the end of November. That should leave little doubt regarding the suitability of weather from the start for black and brown rusts and in the case of yellow from the end of November onwards, yet normally none of these rusts breaks out at Agra before the middle of February. It is conclusive, therefore, that there is no local source of infection in the plains at the time of sowing and that rusts are re-introduced therein, year after year, from some other source. Consequently, rust outbreaks in the plains can only be caused as a result of dissemination of the inoculum from the

hills by the most obvious agency, i.e., the wind.

A comprehensive study of Rust Dissemination was, therefore, started in the year 1932. During the course of this work, arrangements were made for catching rust spores on slides in aeroscopes at 62 representative stations. Spores were also caught at Agra with the help of mechanical traps, kites, and balloons. A few slides were exposed from aeroplanes also at Delhi. Besides the examination of a huge number of slides, 11,355 wind-trajectories were prepared and scrutinized in connection with the initial outbreaks of each of the three rusts, under review, at 20 representative stations. The writer is unable to supply much information on this subject because his second monograph giving details of Rust Dissemination has not yet been published. However, results obtained from work already published are summarised below:—

(1) Uredospores of each of the three rusts were caught from the air, well before its appearance on the local crop at a large number of stations.

(2) The similarity between the physiologic-race flora (the different strains of each rust) of hills and the plains is another proof, and a strong one too, of the fact that the source of all the three rusts, under reference, lies in the hills.

(3) In all probability, black and brown rusts are disseminated from comparatively low altitudes where, on account of milder winter, their uredospores occurring at the time of sowing cause infection on the new crop rather early in the season. In the case of yellow rust, the inoculum must be blown down originally from higher altitudes because, normally, it is unable to survive during summer below 6,000–7,000 ft. a.s.l.

(4) Two important foci where, due to early crops, there is plenty of inoculum, year after year, at the time of sowings in the plains, have been located. These are central Nepal in the north and Nilgiris and Palni hills, taken together, in the south. In addition, hills with altitudes of 6,000 ft. and above are potential foci of all the three rusts. Black and brown rusts may also be disseminated, at least occasionally, from altitudes of nearly 4,000 ft. and above.

Physiologic Races

Just as there are different varieties of wheat, each of the three rusts, under reference, has different strains, better known as Physiologic Races. The occurrence of Physiologic Races within the 'Specialized Form', *Puccinia graminis tritici*, the black rust of wheat, was first recorded by Professor E. C. Stakman of Minnesota, U.S.A.

As elsewhere, this study has been carried out on the lines standardized by Stakman and Levine. The work was started in the year 1932 and the Physiologic Races met with till March 1938 are mentioned below:

(1) Black rust of wheat.—Out of 144 races reported from different parts of the world, only six were found from a study of 586 collections obtained from plains as well as the hills. These are Nos. 15, 21, 24, 40, 42 and 75 of the International list. Races, 15, 40, 42 and 75 were also found on barley from the study of 33 collections. Seven collections from three wild grasses yielded races 15, 40 and 42 of this rust.

(2) Brown rust of wheat.—In 408 collections from different parts of the country, only six races were found. These are Nos. 10, 20, 63, 106, 107 and 108, the last four are new and had not been found anywhere else till the year 1939, when the last International list of 108 races was issued by Humphrey, Johnstone and Caldwell, U.S.A.

(3) Yellow rust.—A study of 236 collections yielded Nos. 10, 19, 20 and 31 out of a list of 38. Besides, four new races that have provisionally been labelled as A, D, E and F were found. These had not been reported from any other country till 1937. Race 19 of this rust was also found in five collections of barley.

The occurrence of a small number of physiologic races in India makes the breeding of resistant varieties more hopeful than is the case in some other countries. During the course of these studies, work in connection with the breeding of rust resistant wheats, for cultivation in the hills, was also started in the year 1935, in collaboration with the Imperial Economic Botanist. Recently, a very promising wheat from Kenya was found to be highly resistant to the most virulent race 15 as well as 40 of black rust, Mehta and Pal.[7] This discovery has greatly simplified the breeding of a wheat resistant to black rust.

Control of Epidemics by Direct Means

Rusts are known to cause huge damage in every country where wheat and barley are extensively grown. No reliable figures are available in this country regarding the

actual loss but considering the acreage of 43 millions under the two crops, taken together, it may amount to 60 million rupees a year. Even this figure might be an underestimate, based as it is on a loss of only 6 per cent. of the value of the entire yield.

Now that the problem under review has been largely solved and we know definitely the sources of initial infection, wherefrom rusts are disseminated year after year, it is time efforts were made to control them. It is obvious that the survival of rusts from season to season only in the hills, which occupy less than 5 per cent. of the entire area under wheat and barley in this country, offers a unique opportunity of control by relatively simple and inexpensive means. The writer's opinion on the practicability of the various methods of combating rusts, with special reference to the conditions in India, is briefly discussed below:—

(1) In order to eradicate rusts at the source, the writer, Mehta,[2] suggested that cultivation of wheat and barley should be suspended in the hills for 2–3 years. This method would be effective only with the co-operation of neighbouring States that own a considerable part of the hilly area.

(2) Dusting the wheat crop with sulphur powder from aeroplanes, which has been attempted on a small scale in some parts of North America, would be impracticable in this country because nearly 80 per cent. of the area is covered by the highly susceptible, indigenous (*dési*) varieties. This method would involve huge expense over weekly applications of sulphur and cost of aeroplanes, etc. Besides, on account of prevailing dry weather during the period of growth of wheat in the plains, most of the sulphur is likely to be blown off the surface of plants, from time to time.

(3) The other method of control, which is universally recognized, is to cultivate resistant varieties. For the reasons given above, in this country it would suffice to grow resistant varieties of wheat and barley *only* in the hills, wherefrom rusts are reintroduced into the plains, from year to year. As stated above, breeding of rust resistant wheats is in progress and it is hoped that similar work on barley will soon be started. In view of the prevalence of all the three rusts in most of the hills the task of breeding a wheat, which would resist them all, is likely to take several years and for an effective control at the source we need also a variety of barley resistant to black and yellow rusts.

(4) 'Clean-up', *i.e.*, rigorous destruction of 'out of season' wheat and barley (self-sown plants, tillers and stubble), which carry over the rusts, 1–2 months before sowing in all the hills and hilly tracts should be an effective method of control in India in view of the small holdings.

(5) Considering the small acreage under *early* crops in the Nilgiris, Palni hills and central Nepal, suspension of the first crop, sown during April–June in the first two areas and postponement of sowings in the last to the normal period, *i.e.*, October, should be the most effective methods of direct control of rust epidemics in the greater part of Peninsular India and the Indo-Gangetic plains, respectively.

In connection with No. (3), it is essential to refer to an important recent observation by Professor Stakman of U.S.A., a leading authority on cereal rusts, stating that rust resistance in varieties so far known is a variable character like any other plant character. Further, that even so resistant a variety of wheat as Hope may rust quite normally when light intensity is reduced and that under cloudy conditions, therefore, when there is considerable moisture, it may be heavily rusted if large numbers of spores are present in the air.

The above conditions of weather are of frequent occurrence in the hills of India and there is a considerable amount of inoculum always present in those parts. It would be wise, therefore, to enforce 'Clean-up' in the hills at an early date and not put it off till resistant varieties are available, when this method will have to be adopted for the success of control by their cultivation. Notwithstanding the difficulties of supervision of 'Clean-up' in the hilly areas and a certain amount of expense to Provincial Governments and the States concerned for such arrangements, the writer is fully convinced that this method is worth attempting and if carried out rigorously should mitigate considerably the huge loss that is caused by rusts, from year to year.

In conclusion, it may be stated that the direct methods of control described under (4) and (5) are practicable and ought to be tried without delay. In the earlier stages of their adoption, rusts may appear here and there but should not break out *early*

enough to cause devastating epidemics over large tracts of the country, as at present. That should lead to a saving of millions of rupees annually whereas the cost over these measures would amount only to a few thousands.

These methods have been approved for trial by competent bodies of the Imperial Council of Agricultural Research as well as by some of the leading scientists abroad and it now remains for Provincial Governments and the States concerned to test their efficacy over a number of years *simultaneously* in their respective territories.

ACKOWLEDGMENTS

The writer wishes to express his warmest thanks to the Imperial Council of Agricultural Research for various grants sanctioned for the continuance of investigations on cereal rusts, with the help of temporary research staff, since the year 1930, prior to which this work was carried out by the writer for a period of seven years at considerable personal expense.

Other acknowledgments due have been fully recorded in the two monographs, referred to above, and for want of space it is unnecessary to repeat them here.

1 Mehta, K. C., *Proc. 12th Ind. Sci. Cong.*, 1925, 191.
2 —, *Proc. 16th Ind. Sci. Cong.*, 1929, **5**, 199.
3 —, *Ind. J. Agric. Sci.*, 1931, **1**, 297.
4 —, *Ibid.*, 1931, **1**, 302.
5 —, *Ibid.*, 1933, **3**, 939.
6 —, *Sci. Mon. Imp. Counc. Agric. Res. Ind.*, 1940, **14**.
7 —, and Pal, B. P., *Nature*, 1940, **146**, 98.
8 Butler, E. J., *Dept. Agric. Ind. Bull.*, 1903, **1**.
9 —, *Fungi and Disease in Plants*, Calcutta, 1918.
10 —, and Hayman, J. M., *Mem. Dept. Agric. Ind. Bot.*, 1906, **2**.

OBITUARY

DR. W. L. DAVIES, Ph.D. (Cantab.), D.Sc. (Wales), F.I.C., N.D.A.

IN the sudden death in Delhi of Dr. W. L. Davies, at the early age of 45, the cause of scientific research in milk and milk products has suffered a grievous loss.

After a distinguished career at the Reading University where he was Advisory Agricultural Chemist to the Southern Advisory Province from 1924 to 1927 and Research Dairy Chemist to the National Institute for Research in Dairying, Shinfield, from 1927 to 1939, Dr. Davies arrived in India to take up the duties of the newly created post of Director of Dairy Research under the Government of India. He applied at once with characteristic enthusiasm to the establishment of an Imperial Dairy Research Institute in New Delhi, but the war unfortunately interfered with the immediate financing of an ambitious project. Undaunted, Dr. Davies approached the Imperial Agricultural Research Institute for such laboratory facilities as can be spared, and, on these being readily offered, he initiated research work on urgent problems of the dairy industry, particularly detection of adulterants in *ghee*. The considerable knowledge which he acquired in the course of a preliminary survey of the indigenous industry he embodied in a brochure entitled "Indian Indigenous Milk Products". The standard of this book is such as to be useful to all interested in the exploitation of milk in India, especially students of dairying, agricultural and animal husbandry, biochemists, analysts and technologists. The other contrbutions while in India include articles on (*a*) Colloid aspects of milk technology, (*b*) Deterioration of butter during storage, (*c*) Conservation of grass, and (*d*) Anti-oxygenic effect of cereal flour paste as a coating on contact wrappers for fatty foods. Dr. Davies' great reputation as a Dairy Chemist will, however, continue to be enshrined in his Monograph on "The Chemistry of Milk" (being Volume 10 of a series of monographs on Applied Chemistry under the Editorship of Dr. Howard Tripp; Chapman & Hall) which was so well received by the scientific world that a second edition was called for within three years of its original publication in 1936.

During the 22 months he was spared to live in India, Dr. Davies made many contacts, and impressed all as a good "mixer" and a devoted scientific worker.

B. V. N.

LETTERS TO THE EDITOR

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ISOTOPE EFFECT IN THE (OH), (OD) BANDS

As was pointed out recently by the author,[1] OH and OD form an interesting pair of isotopic molecules, the band structure of which yields valuable information on the isotope effect in band spectra. The ordinary theory enables the calculation of the vibrational and rotational effects to a first approximation by well-known formulæ[2] in terms of ρ, the mass factor. From the available values of the constants of the OH molecule,[3] the isotopic shifts corresponding to the band heads have been calculated on the above simple theory and presented in the table below. The experimentally observed values, which are directly obtained from measurements on our plates of the spectra of the OH and OD bands are also shown. The disagreement between the observed and the calculated values is genuine and obvious.

v', v''	Calculated isotopic shift			Observed shift
	Vibrational	Rotational	Total	
0,1	1016·9	—138·3	878·7	860·6
0,0	76·7	—89·8	—13·1	—12·4
1,1	240·3	—76·5	163·8	166·7
2,2	417·7	—63·7	354·0	358·6
1,0	—699·9	—57·1	—757·0	—749·3
2,1	—449·1	—49·7	—498·8	—486·7
3,2	—184·5	—42·8	—227·3	—200·1
2,0	—1389·4	—40·8	—1430·2	—1414·8
3,1	—1051·3	—36·0	—1087·3	—1061·8
3,0	—1991·5	—31·1	—2022·6	—1994·5

Johnston and Dawson[4] (referring to three of these bands) indicated that this difference can be explained as due to the effect of spin coupling. In H^1H^1 and H^1H^2 band systems[5] a large electronic isotope shift (as high as 136 cms.$^{-1}$) was observed by Jeppesen. Correction terms[6] arising from the influence of the interaction between the electronic motion and the rotation and vibration are also to be taken

into account in estimating the shifts accurately. A discussion of these applied to the band head shifts and the shifts in the rotational structure of the individual bands will be presented in detail elsewhere.

M. G. SASTRY.

Andhra University,
Waltair,
June 30, 1941.

[1] *Ind. Jour. Phys.* (in press).
[2] Jevons, *Report*, p. 209.
[3] Tanaka and Koana, *Proc. Phys. Math. Soc.* (Japan), 1934, **16**, 365.
[4] *Rev. Mod. Phys.*, 1935, **7**, 83.
[5] Jeppesen, *Phys. Rev.*, 1934, **45**, 480.
[6] Van Vleck, *Jour. Chem. Phys.*, 1936, **4**, 327.

MAGNETIC SUSCEPTIBILITY OF STRONTIUM

THE thermomagnetic properties of some sixty elements were measured in a comprehensive manner by Honda[1] and Owen.[2] The specific magnetic susceptibility of strontium was found to be $-0{\cdot}20$.[3] The observed values of the susceptibility of this element were, however, all positive. Stoner[4] suggested the possibility of an overcorrection for the relatively large iron content. In view of the present uncertainty of the susceptibility of strontium, a careful thermomagnetic investigation of this element was undertaken.

A pure Merck specimen of the metal was available. A spectroscopic examination showed traces of calcium and lead. The Curie method was adopted, taking small quantities of the fused metal in light pyrex glass bulbs. The susceptibilities were determined at field strengths between 3 and 8 kilogauss. The variation of the specific susceptibility with field strength showed traces of ferromagnetic impurities. The susceptibility at infinite field strength was determined from the $\chi, \frac{1}{H}$ graph. The mean specific susceptibility of strontium calculated from observations made on eight samples, was found to be $+1{\cdot}05$. The element was thus found to be paramagnetic.

The gram atomic susceptibility of the metal is therefore $+92{\cdot}0$. Kido's[5] value for the ionic susceptibility of Sr^{+2} is $-15{\cdot}6$. This shows that the two valence electrons of the strontium atom have a susceptibility of $+107{\cdot}6$ (per gram atom of the metal). The width of the occupied energy range in the completely degenerate state of the valence electrons works to about 0·6 volt. Our result supports Stoner's[4] observation that in the alkaline earth elements, the electron energy bands are much narrower than for free electrons.

Experiments on the temperature variation of the paramagnetic susceptibility of strontium are in progress. A detailed account will be given elsewhere.

S. RAMACHANDRA RAO.
K. SAVITHRI.

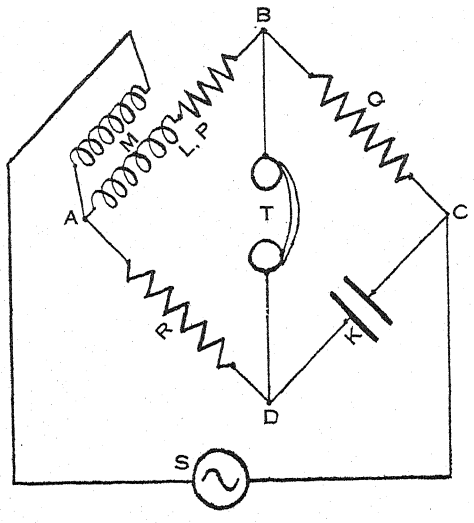
Annamalai University,
Annamalainagar,
August 2, 1941.

[1] *Ann. der Phys.*, 1910, **32**, 1027.
[2] *Ibid.*, 1912, **37**, 657.
[3] All susceptibility values are given in 10^{-6} unit.
[4] *Magnetism and Matter*, 1934, p. 512.
[5] *Sci. Rep. Tohoku Imp. Univ.*, 1933, **22**, 835.

A BRIDGE METHOD FOR DETERMINING THE FREQUENCY OF AN ALTERNATING CURRENT IN THE AUDIO-FREQUENCY RANGE

THE various bridge methods for measuring the frequency of alternating current, so far suggested and employed, have been classified by Hague[1] with reference to their adjustment characteristics and their arm elements. The new bridge whose circuit diagram is shown below has an adjustment characteristic of the form $f = a\sqrt{x}$, which is a parabola.

The branch AB of the bridge contains the primary coil of the mutual inductor M; its self-inductance is L; in series with it an adjustable non-inductive resistance box is connected; P denotes the total resistance, including that of the coil, in the branch AB.



The arms BC and AD contain adjustable non-inductive resistance boxes only; K is a good mica condenser in the branch DC; one end of the secondary coil of the mutual inductor M is connected to that of the primary at A and the other end is connected to the source S of the alternating current whose frequency has to be estimated; T is a telephone used as a detector of the balanced state.

Applying Kirchhoff's rules to the meshes of the impedance network carrying harmonic alternating current and simplifying the equations thus obtained, we get for zero current in the telephone the following two conditions:—

$$(1)\ \frac{L+M}{K} = QR;$$

$$\text{and } (2)\ \omega^2 = \frac{P}{KMQ},$$

where $\omega = 2\pi \times$ frequency.

These conditions of balance can be secured without mutual interference by making R the variable in (1), and P the variable in (2). The practical procedure is as follows: L, M, K and Q being fixed, balance, *i.e.*, silence in telephone is attained by successive adjustment of R and P. The process is easy and rapidly convergent since the two conditions of balance are mutually independent. When the proper values of P and R have thus been fixed up for any frequency, the first condition which is independent of frequency remains satisfied for all frequencies and the bridge may now be employed for determining various frequencies by altering P alone, so that virtually a single adjustment is all that is needed in order to measure the frequencies.

The formula representing the frequency f may be written

$f = a\sqrt{P}$, where $a = (2\pi\sqrt{KMQ})^{-1}$ = a constant. The details of the theory of this frequency bridge and measurements with it will be published elsewhere.

L. M. Chatterjee.

Physics Department,
Science College,
Patna,
June 20, 1941.

[1] B. Hague, *Alternating Current Bridge Methods* (Pitman, 1988) p. 515.

CHROMOSOME NUMBER OF *SESAMUM RADIATUM*, SCHUM AND THONN. BESKR.

In connection with breeding work on *Sesamum indicum*, L. various types and certain other species of Sesamum have been collected in this Section. Seeds of *Sesamum radiatum* which occurs in a wild state in tropical Africa were obtained from Yandev, Makurdi in Nigeria in 1933 through the kind courtesy of the Superintendent of Agriculture, Nigeria. Since then, this species has been grown with fair success at Coimbatore and at the Agricultural Research Station, Tindivanam. The chromosome number of this species has been determined to be $2n = 64$ (Fig. 1), the technique employed being

Fig. 1
× 3500.

fixation of root tips in Lewitsky's fluid to which a pinch of maltose was added and staining of sections cut at 12μ by Feulgen's reaction. It is interesting to observe in this connection that the chromosome number of *Sesamum indicum* is $n = 13$ and $2n = 26$ (Nohara, 1934).

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U. NARASINGA RAO.

Oil Seeds Section,
Agricultural Research Institute,
Lawley Road P.O., Coimbatore,
July 17, 1941.

[1] Sigaroku Nohara, *Jour. Coll. Agri. Tokyo Imp. Uni.*, 1934, **13**, 9.

RIND HARDNESS AS A POSSIBLE FACTOR IN RESISTANCE OF SUGARCANE VARIETIES TO THE STEM BORER

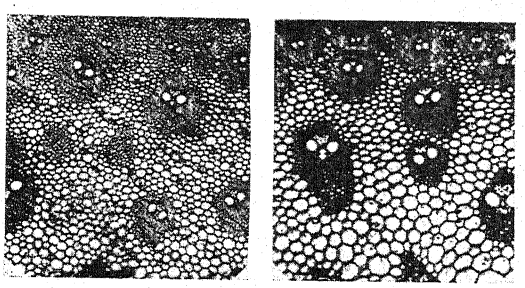
THAT sugarcane varieties differ from one another in their relative resistance to stem borers is a matter of common observation. This has been attributed to differences between varieties in certain characters, such as, rind hardness, fibre and sugar contents and the habit of the variety. Sugarcane breeders are naturally interested in any such correlation as it might place in their hands a means for breeding-resistant types.

It has recently been possible to measure the relative rind hardness of cane varieties by instruments developed both at Pusa and at Coimbatore. Studies have shown that a fair positive correlation exists between the rind hardness of a cane and its resistance to the stem borer, *Diatrea venosata*, as seen from the table below.

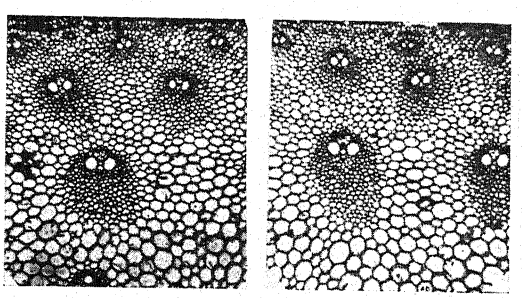
Anatomical investigations were undertaken to study the possible factors that contribute to rind hardness in the sugarcane. It has been found that the three major factors are (1) the number of vascular bundles per unit area, (2) the lignification of cell walls of bundle sheaths and (3) the lignification of parenchymatous cells in the rind region. In any particular variety one or more of the above factors may contribute to its rind hardness. By studying the above three characters, it has been possible to indicate roughly the resistance of particular canes to the stem borer. A general positive correlation has also been found between the fibre contents of a cane and its rind hardness.

Variety	Rind hardness value in lbs.	Percentage of infestation
Co. 421 ..	17·26	29
,, 331 .	16·77	39
,, 313 ..	16·46	42
,, 281 ..	15·24	39
,, 213 ..	14·99	31
,, 290 ..	10·88	52
,, 419 ..	8·40	59
Vellai ..	7·50	62
Poovan .	7·31	69

Rind Hardness Studies



Co. 385 Co. 421
Canes resistant to stem borer



Vellai Poovan
Canes susceptible to stem borer

Indications are available that the anatomical characters mentioned above are inherited in the sugarcane and it might, therefore, be possible to breed resistant canes by a careful choice of the parents for hybridization.

J. THULJARAM RAO.

Imperial Sugarcane Station,
Coimbatore,
July 14, 1941.

[1] Buzacott, J. H., *Proc. Eighth Ann. Conf. Q'ld. Soc. Sug. Tech.*, 1937, 8.

[2] —, *Tech. Com. Sug. Expt. Stn., Q'ld.*, 1940, 8.

[3] Holloway, H. T., *Sug. Bul., New Orleans*, 1935, **11**, 3.

[4] Khanna, K. L., *Ind. Jour. Agri. Sci.*, 1939, **1**, 1.

[5] Pemberton, C. E., *Rep. Comm. Exp. Stn. H.S.P.A.*, 1934, 1.

[6] Ueno, T., *Rept. Govt. Sug. Expt. Stn., Formosa*, 1938, **5**, 21.

[7] Venkataraman, T. S., *Proc. Int. Soc. Sug. Tech.*, 1929, 429.

A PRELIMINARY NOTE ON A *MELAMPSORA* PARASITIC ON *LOBELIA TRIGONA* ROXB.

THE genus *Melampsora* was founded by Castagne in 1843 to accommodate those rusts whose uredia are characterised by the presence of paraphyses and whose teliospores are combined into compact crusts beneath the epidermis or the cuticle. Over 90 species have so far been described of which ten species are reported to occur in India by Butler and Bisby (1931). Some species belonging to this genus cause serious diseases of crop plants, *Melampsora Lini* (Pers). Lev. for example causing much damage to linseed, *Linum usitatissimum* L. in India.

In December 1940, the writer collected near marshy places in Bangalore, a *Melampsora* on *Lobelia trigona* Roxb. which is new to science. A survey of literature indicated, that no species of *Melampsora* has been described on any members of the family *Lobeliaceæ*. The writer proposes to call the rust *Melampsora Mundkuri* Spec. nov. Thirumalachar.

The rust attacks the leaves and twigs of the host, forming yellow concentric patches. Aecia are of the *caeoma* type, characteristic of the genus, and are without any paraphyses. The aecial initials are hypodermal, and the basal cell abstricts off chains of aeciospores, which after rupturing the epidermis are thrown out in large numbers (Fig. 1). The aeciospores are

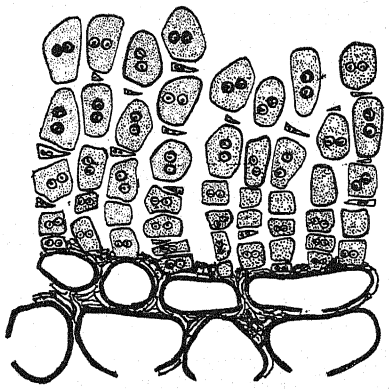


FIG. 1

Camera lucida drawing of an aecium. × 600.

round or oval in shape, binucleate and measure 15 × 8 μ.

Telia appear as waxy orange coloured crusts when fresh, and are distributed on either surfaces of the leaves, and on twigs. They are not erumpent, but occur as sub-epidermal crusts. The telial initials composed of binucleate cells are hypodermal in origin. Mature spores are thick walled and deep brown in colour, with an apical germ pore. Following nuclear fusion, they become syncaryons. The epidermis and the cuticle above the telia are ruptured and thrown out as crusts. Teliospores measure 25–34 × 17–20 μ (Fig. 2).

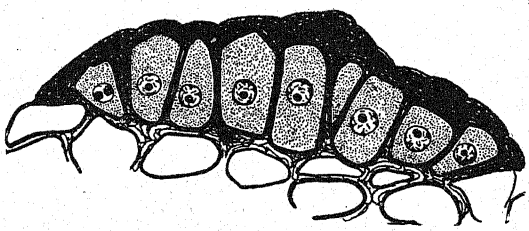


FIG. 2

Teliosorus showing teliospores in a crusty layer. × 600.

A formal description of the species and a detailed account of the morphology, development of the spore-forms and parasitism will be published elsewhere. The writer wishes to acknowledge his indebtedness to Dr. M. A. Sampathkumaran, M.A., Ph.D., Professor of Botany, Central College, Bangalore, for guidance and encouragement, and to Dr. B. B. Mundkur, Imperial Agricultural Research Institute, New Delhi, for valuable suggestions.

M. J. THIRUMALACHAR.

Department of Botany,
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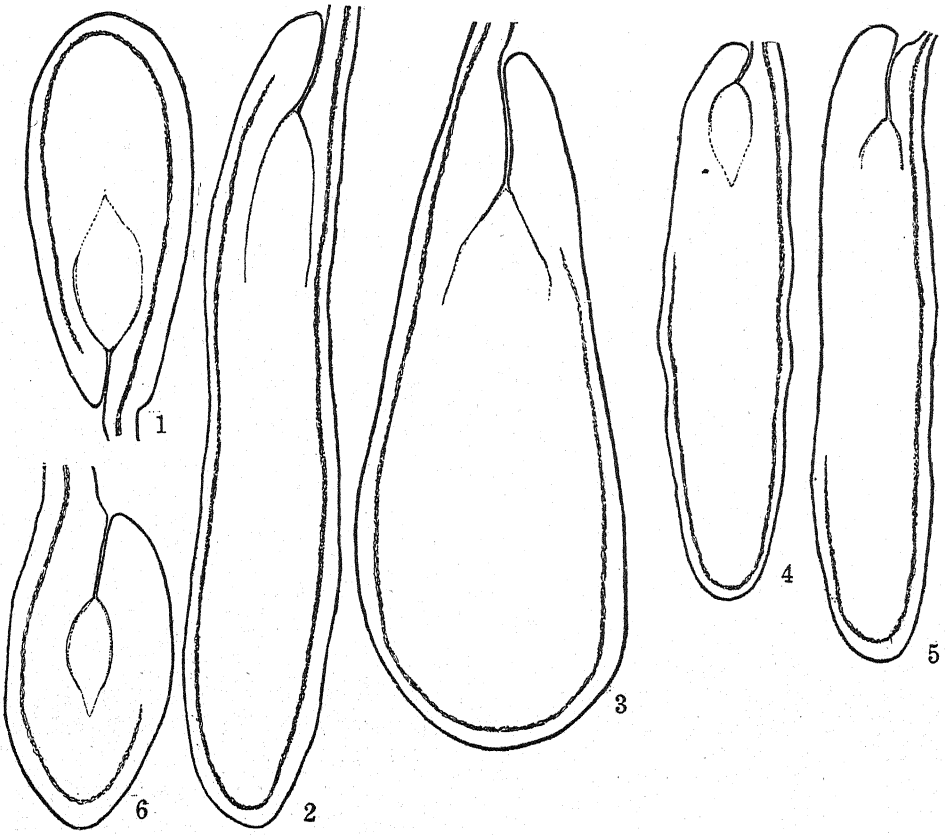
July 11, 1941.

VASCULAR SUPPLY IN THE OVULES OF SOME COMPOSITÆ

THE ovular vascular supply in Angiosperms generally consists of a single vascular strand which travels up the funicle and ends at the Chalaza. In some plants, however, it is found either to continue its course into the integument on the side away from the funicle or to divide into a few branches which ramify in the chalaza or travel up into the integument. Such deviations have been recorded in various angiospermous plants belonging to families falling in diverse cycles of affinity (*cf.* Kühn,[1] 1928; Mauritzon,[2] 1939; Puri,[3] 1934; Schnarf,[4] 1929). In compositæ, the occurrence of integumental vascular traces is previously known in *Helianthus, Centaurea, Sonchus,* etc., in the



Ovules showing the vascular trace in the integument

Fig. 1, ovule of *Tridax procumbens*; Fig. 2, ovule of *Tagetes patula*; Fig. 3, ovule of *Zinnia elegans*; Fig. 4, ovule of *Emilia sonchifolia*; Fig. 5, ovule of *Eupatorium cannabinum*; Fig. 6, ovule of *Cosmos bipinnata*
Figs. 1 & 4, × 39; Figs. 2 & 3, × 31; Figs. 5 & 6, × 54.

ovules of which the vascular trace is found to travel beyond the chalaza, around the ovule, into the single massive integument on the side away from the funicle, while in *Echinops ritro* and *Liatris elegans* it divides into a number of branches in the Chalaza of the ovule (Schnarf, 1931).[5] The writer has found, in the ovules of some compositæ, a behaviour of the ovular trace similar to that observed in *Helianthus, Centaurea, Sonchus,* etc. Entire ovules of *Tridax procumbens, Zinnia elegans, Tagetes patula, Emilia sonchifolia, Cosmos bipinnata, Eupatorium cannabinum, Vernonia cinerea, Eclipta erecta, Gaillardia picta* and *Launea pinnatifida* have been mounted in aceto-carmin and examined. In the last named four the ovular vascular trace has been found to run through the length of the raphe and end at the chalaza as generally found in the ovules of most Angiosperms, while in the rest the vascular trace is found to travel beyond the chalaza, around the ovule, into the single massive integument. It runs up almost to the proximity of the micropyle in *Tridax procumbens, Tagetes patula* and *Zinnia elegans* (Figs. 1–3), upto about half the height of the integument in *Emilia sonchifolia* (Fig. 4) and upto about one-third to less than half in *Cosmos bipinnata* and *Eupatorium cannabinum* (Figs. 5 and 6). The vascular trace is very slender and consists of a few tracheids in its thickness.

J. VENKATESWARLU.

Andhra University,
Waltair,
June 17, 1941.

[1] Kühn, G., *Engler's Bot. Jahrb.*, 1928, **61**. (Summary in *Biol. Abstracts*, 1932, **6**. entry 25584.)

[2] Mauritzon, J., *Lunds. Universitets Årskrift*, N. E., 1939, Avd. 2, Bd. **35**, No. 2.

[3] Puri, V., *Proc. Ind. Acad. Sci.*, 1934, Series B., **1**, 6.

[4] Schnarf, K., *Embryologie der Angiospermen*, Berlin, 1929.

[5] Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.

NOTE ON THE INFECTION OF COPEPOD (*DIAPTOMUS*) WITH LARVAL TREMATODE*

WHILE examining some copepods collected from one of the freshwater ponds in Bangalore, Mysore State, India, in connection with certain investigations on dracontiasis, it was observed that a specimen of *Diaptomus* was naturally infected with a larval trematode. It is proposed to present in this paper a brief description of this parasite.

The larva was found sluggishly moving in the body cavity of *Diaptomus*.

Description.—Body oval in shape, 0·251 mm. long, narrow and bluntly pointed at the extremities and wide in the middle; maximum width slightly posterior to the oral sucker, 0·13 mm.; and 0·081 mm. wide in the region of the oral sucker and also in the region slightly posterior to the ventral sucker. Cuticle delicate, slightly thickened at the extremities, traversed by fine cross striations. Oral sucker oval, 0·066 mm. by 0·044 mm. situated 0·021 mm. from the anterior extremity, opening transversely oval, 0·021 mm. by 0·01 mm. Pharynx 0·046 mm. long and 0·028 mm. wide. Ventral sucker circular, with a 0·1 mm. in diameter, with circular opening 0·042 mm. in diameter, situated 0·1 mm. from the anterior extremity. Tail about one and one-fourth the body length (0·31 mm.) and is a continuation of the posterior end of the body.

This trematode appears to belong to the family Hemiuridæ.

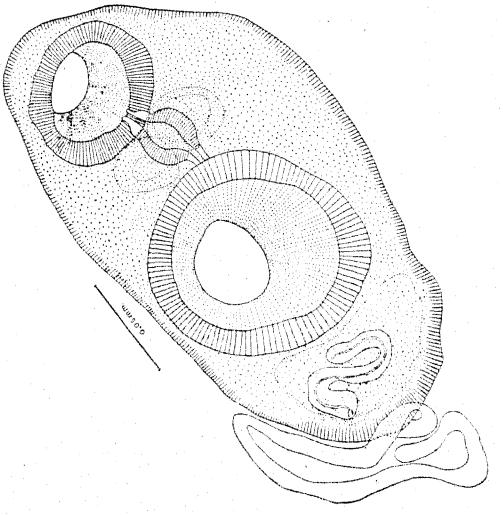
Diagnosis of female (male not known):

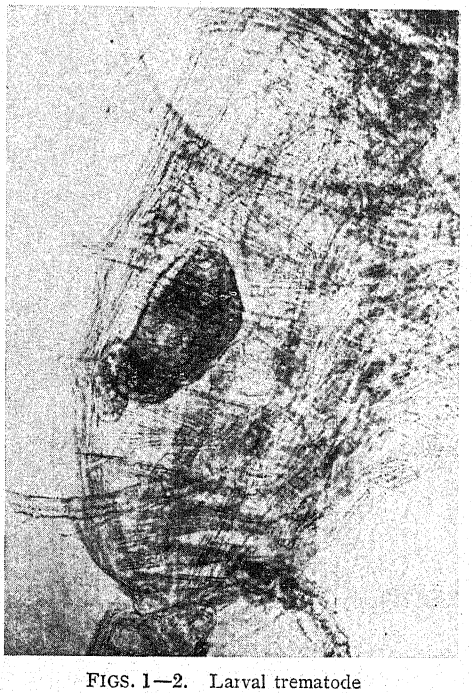
Body compact, convex dorsally, somewhat compressed; total length, excluding caudal setæ, 1·55 mm.; length of cephalothorax 0·5 mm.; length of metasome 1·1 mm.; length of genital

* The writer is greatly indebted to Dr. E. W. Price, Zoological Division, United States Bureau of Animal Industry, for valuable help and guidance given. The description of the *Diaptomus* Sp. given in the appendix was prepared in co-operation with Dr. Olga Hartman, United States National Museum, Washington, D. C., to whom the writer is greatly indebted for the ready help given.

segment 0·5 mm.; length of uroscme 0·25 mm. Greatest thickness, at posterior end of cephalothorax, 0·5 mm.

Antennæ consisting of 27 distinctly articulated segments; moderately long, extending distally to the anterior end of the caudal rami. Metasome composed of 5 segments including cephalothorax, the latter slightly more than 1/3 of its total length. Post lateral edges of metasome with 2 small spines, one at extreme posterior edge and another slightly anterior and lateral to it. Abdomen of 2 segments, a genital segment which is longer than broad, and a second segment only 2/7 as long as the first segment. Length of caudal rami about 1½ times their width, each provided at their distal end with 5 stout, plumose setæ and a slenderer inner one which is biarticulated (Fig. 4).

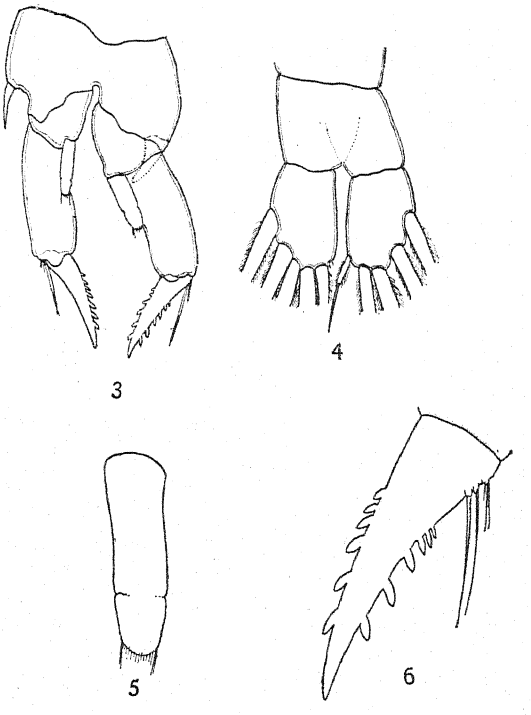




FIGS. 1—2. Larval trematode

Fig. 1.—Camera lucida drawing of the larval trematode

Fig. 2.—Photomicrograph of the larval trematode situated in the body cavity of a *Diaptomus*. × 100.



FIGS. 3—6. *Diaptomus* Sp.

Fig. 3.—Fifth feet of female in ventral view. × 170.
Fig. 4.—Caudal rami in dorsal view. × 170.
Fig. 5.—Endopodite of left fifth leg. × 525.
Fig. 6.—Distal spine from left fifth leg. × 525.

Fifth pair of legs as follows:

Left leg longer and stouter than right, its basal segment with a stout, blunt curved spine on the dorsolateral edge (Fig. 3). Endopodite small, greatly outdistanced by exopodite,

indistinctly 2-segmented, the proximal segment about twice as long as wide, the second segment slightly longer than wide, rounded distally, provided with a few longer setæ at its ectal margins and more numerous delicate setæ at its medial tip (Fig. 3). Exopodite with third segment more than twice as long as broad, its distal spine heavy, about 2/3 as long as segment 3, provided on each side with 6 stout tubercles which increase in size from proximal to distal end. Two long and several shorter setæ are inserted at ectolateral edge of segment 3 (Fig. 6).

Right leg similar to left, but differing as follows: basal spine shorter and slender; distal spine with a single row of 7 stout tubercles increasing in size as in the left leg.

Known from a single specimen infected with a larval trematode.

Type:—In the collection of Friedrick kiefer karlsrune (Baden) Karlstr. 128 (Germany).

Habitat:—Bangalore, South India.

Place of Collection:—Freshwater pond.

V. N. MOORTHY.

Department of Public Health,
Bangalore,
August 2, 1941.

SULPHUR POSITION IN INDIA

I HAVE read with interest the article entitled "The Sulphur Position in India" by Sir S. S. Bhatnagar, Director, Board of Scientific and Industrial Research, which appeared in a recent number of *Current Science*.[1]

It is really gratifying to note that the Board of Scientific and Industrial Research has diverted some attention to the question of recovery of sulphur from coal. Sir S. S. Bhatnagar has referred to the wakting (possibly also known as watching) coal of upper Assam and has indicated the organic nature of the sulphur compounds in that coal. He has also suggested that sulphur compounds might be extracted by solvent processes or by steam distillation; preliminary work has shown, however, that extraction by solvents is pretty difficult and I think it is very doubtful if such extraction process can be carried out on a commercial scale and on an economic basis. Moreover, as a result of extraction by some organic solvents (I mention this from my experience), the caking property of coals is very much reduced, thus producing a deleterious effect on the coal residue. Though the sulphur content can thus be reduced to some extent, the residual coal may not be found suitable for manufacturing good coke.

It is fairly well known, that apart from consideration of sulphur content, many of the Upper Assam coals are considered to be of the highest grade metallurgical variety with minimum ash. Such coals with extremely low ash (sometimes as low as 1% or even less) are to be found nowhere else in India. Though by means of the extraction process, using organic solvents, some sulphur compounds may be leached out and recovered, the quality of the residual coal will be affected.

Sir S. S. Bhatnagar suggests, in the paper, that if the sulphur compounds can be removed by a cheap process from the coal, the coal itself will become more useful and a good price could be fetched by working the sulphur compounds. But he has not given any indication as to how such a process could be evolved.

It may be mentioned, in this connection, that a series of experiments with many high sulphur Tertiary coals of India were carried out by me for the quantitative determination of various sulphur forms in them.[2] In a paper[3] communicated to the Indian Science Congress, I have indicated some methods for reducing the sulphur content of the coals of Upper Assam, and for producing high class metallurgical coke with permissible amounts of total sulphur. Blending of non-caking coals with caking ones are expected to solve the problem of unusual high swelling in some caking coals.

It was reported in that paper, that laboratory investigations had shown that a good proportion of sulphur compounds could be eliminated in the form of gases during the time of

carbonisation. These results are of interest to the Coal Industry. Experiments on a semi-industrial scale have to be carried out to see how far the laboratory methods might be successful in actual practice. The treatment of sulphur high coals with sodium chloride, hydrogen or cheap producer-gas in the carbonisation chambers erected for the purpose, is well worth investigation. This work may be taken up by the Board. The gaseous products thus obtained may easily be subjected to Thylox or any other suitable process for the recovery of the sulphur compounds. The coke residue in the chamber ovens will form a suitable product for high class metallurgical operations. In the case of non-caking coals the non-coherent residue in the ovens may be briquetted and used for steam raising purpose or can be blended with high swelling coals to give better results. The non-caking coals may also be profitably employed for blending prior to high temperature carbonisation. It has not been, however, yet possible to find out simple ways and means to reduce the sulphur content of the coals thereby making them suitable for use in lumps on the grates of boilers.

These aspects of the problem will perhaps be of interest to the members of the newly formed Sulphur Committee.

N. N. CHATTERJEE.

Post-Graduate Dept. of Geology.
Presidency College,
Calcutta,
June 11, 1941.

[1] *Curr. Sci.*, 1941, **5**, 245.

[2] *Quart. Jour. Geol. Min. & Met. Soc. of India*, **3**, 101; **10**, 135; **9**, 157; *Proc. Nat. Inst. Sci. Ind.*, **6**, 523.

[3] *Proc. Ind. Sci. Congress*, Benares, 1941, Part 3, 138.

A MARGOSA TREE WITHOUT THE BITTER PRINCIPLE

I HAVE read with interest the brief note by Mr. Cherian Jacob on "A Margosa Tree without the Bitter Principle," published in the July number of *Current Science*.

On *prima facie* grounds Mr. Jacob's explanation seems sound. But it needs to be followed up. It should not be difficult, without appreciable damage to the trees, to cut out a block of wood deep enough to include portions of both the trees, to section it in order to confirm the presumed grafting of the tissues, and to ascertain the exact nature of the connection.

Assuming that there is an intercommunication between the saps of the two trees, several possibilities suggest themselves. It may be, as Mr. Jacob suggests, that the banyan's sap, passing into the margosa, exercises a neutralising influence on the bitter principle. On the other hand, it is possible that the bitter principle of the margosa diffuses into the banyan and may even render it bitter to the taste. A comparison of this banyan's sap with that of others is therefore indicated.

Natural fusions between plants of widely different affinities are not a rare occurrence. After all, parasitic connections such as that between a *Cuscuta* and its hosts (and it is notorious that these may belong to many different families) are to be counted among such natural fusions. It is probable, too, that grafting of tissues can be effected artificially between plants belonging to distant groups. What is worthy of enquiry is whether we can, by this means, improve the quality of fruits by eliminating undesirable flavours due to resins, latex and other substances.

B. SAHNI.

The University,
Lucknow,
August 4, 1941.

CORRELATION AND TIME SERIES

BY

D. D. KOSAMBI

(*Fergusson College, Poona*)

IN a recent attempt to examine the significance of reverse marks on Taxilan silver punch-marked coins, 753 square coins found in a pre-Mauryan hoard were tabulated by weight in arrays of 0, 1, ..., 10 reverse marks. The correlation r between reverse mark and weight was found to be $-\cdot 46$. Because the evidence pointed to the reverse marks being regularly placed in time, 3,000 current British Indian rupees were taken from active circulation, and their weights determined as a control measure. Discarding counterfeits, mint-defectives, and the (superseded) rare Victoria rupees, there remained 2,886 specimens in 18 arrays, one for each year from 1903 to 1920. The correlation between date of issue and weight was found to be ·43, which is compatible with the Taxilan value. The two values would actually be closer if Sheppard's corrections were applied, because the grouping unit for British coins is coarser, ·01 gm. (though the coins were weighed to ·0001 gm.) as against ·1 gr. for Taxilan specimens. The question as to this correlation value being a characteristic of all coinage regardless of period and denomination can only be settled by numerous observations on other currency. However, an affirmative result need not be taken as surprising because r measures the strength of association between time and weight in a manner that is independent of the unit of time, and of weight, therefore independent of the rate of wear. It is just possible that the extent to which date of issue is relevant information as regards the mean weight of the group remains the same over a large geographical region and great duration of time.

The next step is to examine whether the correlations give equally good linear regressions in both cases. The relevant information is summed up in Table I.

TABLE I

	D. F.	Sum Squares	Mean Squares
British			
Lin. regression ..	1	15423	
Deviations from regression	16	1130	70·63
Within arrays	2868	65563	22·86
TOTAL ..	2885	82116	
Taxila			
Lin. regression ..	1	20712	
Deviations from regression	9	2389	265·44
Within arrays	742	73502	99·58
TOTAL ..	752	96603	

(Figures rounded off from machine calculations.)

This increases the resemblance between the two coinages, as we see that the regression is very highly significant in both cases, and that the deviations from regression are just over the ·1 p. c. level of significance, when tested against the estimated variance within arrays, by Fisher's z test. But the story changes if we fit quadratic regressions. For British coins, the deviations from a quadratic regression have the sum-square 1092, which with the loss of one degree of freedom actually makes the deviations a little more significant; in the Taxilan case, we have the sum-square reduced to 938, which gives a mean square for deviations 117·31, quite insignificant. So, it is clear that no regression could fit appreciably better than the quadratic for Taxila, while the British deviations are due to other causes than a non-constant rate of wear with time. Both of these are to be expected, inasmuch as for all times, the tendency to get rid of a "bad" or worn coin heightens the rate of wear with age; and for Taxila ten reverse marks cover something like 120 years so that one need not expect the same rate of wear to apply throughout the period. For the British currency, the war period 1914–18 was one of absorption of coin, which flooded the market after the war and caused a stagnation of the 1918–20 issues. Besides, the time of sampling (August 1940) was one of extreme currency panic. Finally the sample taken at Poona can hardly be called truly representative of the vast numbers minted—at varying rates—and

issued according to the needs of various parts of the country. That is, the British deviations are due in my opinion primarily to inefficient sampling and irregularity of the actual date of issue of the currency in question.

Perhaps the most curious feature of the investigation was the fact that mean values for both coinages lie practically on a straight line, when the graph is drawn. But the correlations are comparatively low. I mean to show here that this is a feature common to time series in general, where the correlation as calculated from the usual formula must necessarily be an underestimate of the population value. For the case in hand, theory proceeds on the assumption that the minted weights show a normal distribution, and that the loss due to wear is also normal. With these (or slightly more general) assumptions, we are led to what is known as the homogeneous random process, which is fundamental in the flow of heat, diffusion, the kinetic theory of gases, Brownian movements, the theory of speculation, and certain actuarial phenomena. For our purpose, it is enough to deduce that the means are regularly depressed with age, the variance increased; both obeying equations linear in time. There is an additional factor for absorption of currency, of type exp-bt, but this does not affect weight distribution within an array. It is also seen that the numbers in one array are independent of those in another unless the rate of issue is constant and that of absorption is known to be exact. All this does not give us a population in bivariate normal correlation. For a population of this latter type, one finds (in representative samples) the entries vanishing outside of an elliptical region of the tables, and the numbers thinning out towards the boundary of this ellipse; and this is theoretically to be expected. In a time series in general, there is no reason for this to happen. In fact, for a time series, the variance of the time is usually infinite, the ellipse of error being then drawn out into two straight lines. All the arrays, for such a time series, taken together only amount to a very thin slice taken from near the centre of a proper distribution in bivariate normal correlation.

One should not be surprised, therefore, if the calculation of r by the usual formula leads to something entirely different in the case in hand. To take a theoretically perfect example, let there be $m+1$ arrays labelled 0, 1, ..., m; in the pth array, let the number of specimens be n_p, their mean weight $a - bp$, the sum of squares of the deviations from the array mean $n_p(u^2 + pv^2)$. The average weights then lie exactly on a straight line, and the population correlation should be unity. But calculating by the usual formula we obtain

$$r^2 = \frac{b^2(\beta - \alpha^2)}{u^2 + av^2 + b^2(\beta - \alpha^2)}$$

where $N = \sum_0^m n_p$; $\frac{1}{N}\sum_0^m pn_p = a$;

$$\frac{1}{N}\sum_0^m p^2 N_p = \beta.$$

Moreover, the sum of squares within arrays is $N(u^2 + av^2)$, that between arrays being $Nb^2(\beta - \alpha^2)$; so, in place of the correlation coefficient r, we have actually obtained the correlation ratio η and unless the variation vanishes in each array (which is theoretically impossible) r^2 (here η^2) is always less than the population value (here unity), which can be approximated only by increasing the number of arrays indefinitely, not by merely taking more and more coins in a finite number of arrays. In fact that latter process leads to a quantity distributed not like the square of the correlation coefficient, but asymptotically like χ^2/N, which function has also been proposed as a measure of the correlation in place of r, or η.

In practice, the r^2 calculated as above amounts to taking the ratio of the sum of squares due to regression to the total sum of squares. In its place, *I suggest that for time series the sum of squares due to regression be divided by the total sum of squares between arrays for an estimate of ρ^2 which amounts to calculating the correlation coefficient from the weighted array means.* This is a better estimate of the "population value", and the degrees of freedom are now based on the number of arrays alone. These "adjusted" correlations are, for Taxila $\bar{r} = \cdot 946$; rupees $\bar{r} = \cdot 965$. Of course, this should be applied only to time series as such, in which it is known that the time variate has not a finite variance, and does not yield a population in bivariate normal correlation.

Tests of significance by analysis of variance might be justified in all cases. But those who insist upon the validity of the usual formula for r even in the time series would find it difficult to say just what population constant is estimated thereby. A population is said to be in bivariate normal

correlation when its probability density is given by

$$\frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \exp - \frac{1}{2(1-\rho^2)} \times \times\left\{\left(\frac{x}{\sigma_1}\right)^2 + 2\rho\,\frac{x}{\sigma_1}\,\frac{y}{\sigma_2} + \left(\frac{y}{\sigma_2}\right)^2\right\},$$

where s_1, s_2, r are estimates of σ_1, σ_2, ρ. Taking, for simplicity, $\sigma_1 = \sigma_2 = \sigma$, the axes of the error ellipse are found to be proportional to $\sigma\sqrt{(1+\rho)}$, $\sigma\sqrt{(1-\rho)}$. Making ρ tend to unity while σ approaches a finite limit means letting the ellipse shrink down to one of its axes as a line segment. The bivariate population then degenerates into one with a single variate whose variance is easily found from the corresponding axis, while the other axis tends to zero length. But in order to represent the usual time series, the ellipse must degenerate in other ways, a simple example being $\rho \to 1$, $\sigma\sqrt{(1-\rho)} \to a$. Here, one of the two axes becomes infinite, the other remaining finite. The ellipse is then stretched out into two parallel lines. Without an entirely new definition, the "population correlation" here can only be taken as unity. Attaching the usual meaning to the r formula is, therefore, now out of the question.

COMMENSALISM IN SPONGES*

BY

D. W. DEVANESEN AND P. I. CHACKO

(Department of Industries, Madras)

WELL-KNOWN examples of commensalism in the animal kingdom are found between crabs and sea-anemones. The sea-anemone *Adamsia* lives in association with a hermit-crab. The crab *Dorippe* carries a sea-anemone on the top of a bivalve shell which is mounted on its back and held in position by its hind pair of legs. But among the Krusadai littoral fauna are found instances of commensalism in siliceous sponges which being extraordinary deserve the special notice of naturalists.

(1) The sponge *Spirastrella inconstans* (Dendy) has imbedded in the outer portion of its body numerous cirripedes of the species *Balanus longirostrum* (Hoek). The sponge belongs to the family *Clavulidæ* of the order *Tetraxonida*. It is common all round the island, especially on the south-western side. The sponge is composed of a bunch of stout, erect, digitate processes springing from a basal mass. Its colour is light brown; and it is often washed ashore. The cirripedes evidently draw their supply of food through the current of water set up by the choanoflagellate cells of the sponge. The cirripedes have therefore to expend little or no energy in producing the current. In return the sponge probably gains mechanical support by the inclusion of the exoskeleton of the cirripedes. The sponge may also help itself to surplus food-material broken by the cirripedes into finely divided grains. The number of barnacles in a sponge is very variable; but on an average there are fifteen barnacles to thirty-five grammes of the sponge, thus showing that the barnacles are rather sparsely distributed.

(2) The sponge *Adocia dendyi* (Burton)[1] is another example; but here the commensal is an alga, *Ceratodictyon spongiosum* (Zanard).[2] Further, as this is an intimate association between an animal and a plant, it is an example of symbiosis. For the symbiotic life sunlight is necessary. As the host occupies shallow flats, sunlight can reach the alga and photosynthesis is possible, the alga liberating oxygen for the choanoflagellates from the carbondioxide supplied by the latter. The sponge belongs to the family *Haplosclerida*, of the order *Tetraxonida*. The sponge is found all round the island within the one-fathom zone, and is frequently washed ashore by waves. The alga belongs to the family *Gracilariaceæ* of the group *Rhodophyceæ*. The sponge when fresh is light green in colour. In this case also, the sponge does derive some rigidity by the presence of the branching alga.

* Published with the permission of the Director of Industries and Commerce, Madras.

[1] The sponge was identified Dr. by M. Burton, D.Sc., of the British Museum, London.

[2] The alga was identified by Prof. M. O. Parthasarathy Iyengar, University of Madras.

REVIEWS

Physical Constants of Hydrocarbons. By Gustav Egloff. (Reinhold Publishing Corporation, New York), 1940. Pp. 605. Price $12.00.

The present volume is the second of the four-volume work on the collation and systematic study of the important physical constants of different classes of pure hydrocarbons. In the first volume which was published in March 1939 (*cf.* this Journal), physical constants of the paraffins, olefins, acetylenes and other aliphatic compounds were fully described. Physical constants of cyclo-paraffins, cyclo-olefins, and other alicyclic compounds are reported in this volume which in 605 pages covers nearly every known pure hydrocarbon in these series. The enormity of the task can be gauged from the fact that alicyclic hydrocarbons are available in nature in enormous quantities. Of the oil production of the world for 1939 which was about 2,000,000,000 barrels, 500,000,000 were cyclo-paraffin hydrocarbons and they are largely consumed as motor fuel, gas oil, kerosene, diesel oil, lubricants and fuel for household and industrial purposes. The physical constants of the alicyclic compounds have not been studied with the same degree of accuracy as those of the paraffinic series owing to the recognition of their special advantages only during recent years.

The book deals with a brief introduction on the subject and includes such important considerations as:

(*a*) Structure of alicyclic hydrocarbons,
(*b*) Mono-cyclic rings of the alicyclic series,
(*c*) Cycloparaffins containing fused rings,
(*d*) Double and triple bonds in alicyclic hydrocarbons,
(*e*) Geometrical isomerism, and
(*f*) Nomenclature of alicyclic hydrocarbons.

Four physical constants namely the melting point, the boiling point, density, and refractive index for every compound are given in as many cases as literature makes it possible. Additional data are occasionally given which add to the value of these constants and establish their accuracy. The volume is really a dictionary of constants and the reviewer has very little to add excepting to confess that the work is a strenuous effort which must have cost lot of patience and time and should be utilised by workers in petroleum industry and students of hydrocarbon chemistry. Further research, however, will probably lead to many corrections in the actual values of the constants, as it is only during recent times that the need for a systematic study of the physical properties of pure hydrocarbons has been felt.

In these investigations on the purity of hydrocarbons, new physical discoveries such as Raman effect, the molecular scattering of light by pure substances and the X-ray methods of analysis have already played an important part. Other physical properties such as dipole moments and viscosities will probably be of equal importance and the constants obtained by the methods will probably find a fitting place in new editions of this otherwise useful book.

S. S. B.

Hydraulic Measurements—*A Manual for Engineers.* By Herbert Addison. (Messrs. Chapman & Hall, Ltd., London), 1940. Pp. x + 301. Price 21*sh.*

This book forms a companion volume to the author's earlier work "A Text-Book of Applied Hydraulics" which has now run through the second edition. It is mainly intended to be a practical manual for engineers and gives experimental details for all the methods available for the measurement of the pressure and flow of liquids. The progress made during the last two decades in the scientific study of the laws of hydraulic flow has enabled the author to formulate the laws on a more stable basis than hitherto. He has also given full weight to the practice adopted on the continent and embodied in the book *the work of Irrigation Engineers in Egypt and India.* Now-a-days, when more and more attention is being paid to the metering of city water supplies, the methods described for stream gauging will be found very useful by Municipal Engineers. Similarly, due to the development of the oil and petroleum industries and the immense increase in the use of liquid fuels, the metering of piped discharges has assumed very great

importance and the book deals exhaustively with this.

The author assumes considerable acquaintance on the part of the reader with the theory of Hydraulics and no theory is given regarding any meter or instrument. An actual meter is described and the method of using it with all possible sources of error and necessary precautions to be taken are given in detail.

The whole of the first chapter is devoted to direct reading meters for the measurement of depth, head and pressure and the second chapter with indirect reading meters. Installation and operation of pressure and depth gauges is dealt with in the 3rd chapter and the next three chapters deal with the measurements of weight and volume, velocity and discharge. The measurement of discharge in closed pipes is dealt with under three heads, (1) Quantity meters, (2) Rate of flow meters, and (3) special methods and a separate chapter is devoted to each. Similarly, the measurement of discharge in open streams, by free flow methods, by weirs and flumes, and by regulating sluices and by scale models is discussed in great detail, each occupying one separate chapter. The twelfth and the last chapter deals completely with indicating, recording and integrating instruments for flow-measuring installations.

The author has made the actual use of each and every appliance mentioned in the book more intelligible by the introduction of photographs and hand sketches wherever possible. One very attractive feature of the book is that any doubts that one may have with regard to the practical use or calculations relating to any meter, are cleared by the profuse introduction of worked examples at each stage.

E. K. RAMASAMI.

An Introduction to the Study of Air Mass and Isentropic Analysis. By Jerome Namias. (American Meteorological Society, Mass.), 1940. Pp. 232. Price $1.25.

The book is a valuable asset to every student of meteorology. A number of experts have made contributions to it, and its popularity is shown by the present edition being the fifth edition in five years.

The book opens with an introduction by J. Namias and a discussion of the conditions of atmospheric stability, and the properties best conserved by air masses during their movements, properties by which they can be identified and distinguished. The Rossby diagram, its interpretation and applications are dealt with in two sections, followed by three sections devoted to warm and cold 'fronts' and the elements of cyclonic structure. The Norwegian wave theory of cyclones is expounded in a few pages by B. Haurwitz. The eighth section deals with the 'Tephigram' of Shaw and its application in forecasting weather by a study of the upper air. A study of the origin, classification and forecasting of thunderstorms is given in the next section.

Having shown that a study of air masses and fronts, and their movements and modifications is of great importance in explaining and forecasting weather, in the next part of the book, pp. 72–108, H. C. Willet takes up a detailed study of the sources, classification and characteristic properties of North American air masses, their movements and modifications and their significance in weather production. These studies are continued in pp. 109–113 by Al. K. Showalter, and the following pages 114–35 contain charts illustrating the features and phenomena described.

Section 10, pp. 136–75 by J. Namias expounds the analysis of meteorological factors and events through a study of 'isentropic' surfaces, with a number of illustrations and charts. The importance of upper air data for such analysis is brought out.

A noteworthy feature is the very extensive and detailed bibliography, pp. 176–227, classified under 10 headings and 27 subheadings, with over 1,900 references. The last five pages contain a glossary of technical expressions. The different recent methods of analysis of meteorological data for the study and forecasting of weather are explained in the book in a concise manner with illustrative charts on a large scale. No keen student of meteorology should be without a copy of this book.

A. VENKAT RAO TELANG.

Handbook of Economic Entomology for South India. By T. V. Ramakrishna Ayyar. (Government Press, Madras), 1940. Pp. xviii + 528. Price Rs. 4–12.

According to the author the book has been compiled from lectures delivered by him to the students of Madras Agricultural College for over twenty years and is especially intended for agricultural students and educated farmers of South India.

Part I of the book deals with general entomology, in a lucid and simple style showing the position of insects in the animal kingdom and their importance. It then deals briefly with the external and internal system, physiology, reproduction and growth of insects, the general features in the activities of insects and lastly with insect classification. The most important feature in Part I is a simple key to recognise the important insect groups of South India. This key in most cases should make it possible to quickly locate the order of any common insect of importance referred to in the book and will be helpful to all agricultural students in India.

Part II deals with economic entomology, insect pests of cultivated plants including the chief agricultural crops of South India, vegetables, fruit trees and of other plants yielding dyes, drugs, spices, etc. This part also acquaints the reader with pests of garden plants, fodder crops, some useful trees of the plains, pests, affecting food products, cattle and domestic animals. There are also brief references to methods of control of the various pests. The author has also briefly dealt with household, and disease-carrying insects and a few beneficial insects of productive and helpful forms. The book ends with four useful appendices and a list of reference to literature on South Indian Entomology.

In short, the book is packed full with information on the various aspects of entomology and is not only a good text-book for agricultural students but an attractive guide to those whose interest in entomology is casual.

An outstanding feature of the book is the abundance of illustrations most of which are clear and simplified but in a few important cases the simplicity and clearness have been marred by reduction in size, overcrowding of many figures in one illustration and faint lettering, *e.g.*, in Fig. 3A, it is difficult to read names of bones and in 3B it is difficult for a beginner and a layman to find out what and where the chitinous exo-skeleton is; Figs. 60 and 61, illustrating several biting and sucking insects along with the nature of damage caused by them, have been crowded together, making the illustrations less informative and educative about the form of the insects and nature of the damage caused by them; Figs. 76 and 77 which respectively illustrate the calendar of important pests of chief crops other than paddy and Madras insects which become pests only in certain years, the food plants, insect pests and lettering are not prominent and clear; this has greatly affected the value of these illustrations.

The author has been unkind to the insect world by reducing their estimated population from seventy-five to sixty per cent. of the living species of animals. American spellings have been introduced here and there; on page 28 one of the definite functions assigned to fat bodies is that of excretory organs though the opinions of workers greatly vary on this point. In spite of the earnest attempts and appeals of the entomologists to follow uniform terminology words like 'deterrents' have been used for 'repellants', etc.

Under chemical methods of insect control by the use of non-arsenical materials like sodium fluoride which are more in use these days for treating vegetables and fruits against biting insects, short notes on use of easily available ones would have been useful to the farmers.

To the reviewer's regret, the author has made certain inaccurate statements in the chapters on beneficial insects, *e.g.*, Lac is called an ingredient of shellac when in fact shellac is nothing but purified lac; the name of the most common lac insect has for some years been changed to *Laccifer lacca* but the author still calls it *Tachardia lacca;* there are both apterous and winged males among the lac insects, the former class being more prevalent but the author has mentioned only winged males; even the winged male does not fly out of its resinous covering as stated by the author but crawls out like an apterous male. The scraped lac when coarsely crushed and washed is called 'seed lac' and not 'lac'. Shellac is not made by boiling 'the powdered seed lac encrustation with a chemical like yellow arsenic or orpiment' but by filling the seed lac in a long narrow bag, melting it and forcing it through the cloth by pressure; the orpiment is not at all necessary for this purpose but is sometimes used only to lighten the colour of dark coloured lac. In the list of provinces where lac is cultivated on a fairly large scale, omission of Bihar which produces over three-fourths of the total production is regrettable. Mistakes of this type could have been easily omitted if recent publications on lac had been referred to. In his own

province of Madras, the author has mentioned his own small efforts of growing lac on certain hosts but has not mentioned large-scale lac cultivation by the Madras Government in Salem and Madura.

Either adding another appendix or arranging appendix 'A' according to important food plants and giving the names of chief insect pests with their orders in brackets against the food plants would prove more useful and handy to the readers than the present arrangement. In spite of the errata, there still remain a few printing errors which perhaps are inevitable in a first edition. The printing also is not as attractive and neat as it should be for such a useful book.

These criticisms, however, do not detract from the enormous value of the book to those for whom it is especially meant. It is also patent that the author took great pains in preparing his college lectures and finally compiling the present book which should prove more useful to the agricultural students and educated farmers in India than some books on foreign agricultural entomology now in use in India.

P. S. NEGI.

Principles and Practice of Chromatography. By Zechmeister and Cholonoky. English translation by Bacharach and Robinson. (Chapman & Hall, Ltd., London), 1941. Pp. 362. Price 25*sh.*

Few will disagree that science advances as much through presentation of an important problem as through the invention of a new technique. Referring to the latter some twenty years ago Emich and Pregl perfected the method of micro-analysis to such a degree that many a chemical problem could now be attacked which was previously given up as impossible. During the last ten years the "Chromatographic procedure" has likewise revolutionised chemical manipulation, both in isolation as well as in purification of compounds. For example Lactoflavin or Vitamin B_2 is present as traces in milk; it was impossible to isolate it by any other technique. It was finally concentrated by adsorption on alumina and recovered through elution by means of benzene and methyl alcohol. Among cancer producing hydrocarbons it was necessary to obtain substances in an ultra-pure condition since their potency was apparent when they were present even in traces. Dibenzanthracene as ordinarily obtained was accompanied by a trace of an yellow coloured impurity. The classical methods of purification were all found useless for purifying dibenzanthracene; the purification was achieved by the application of chromotography.

Chromatography was developed by the Russian Botanist, Tswett, in 1906 but was entirely neglected until the German Chemist, Richard Kuhn used it in isolating Lactoflavin in 1931 and several polyene pigments subsequently and thus showed its importance.

So much work has been done by its help within these ten years that enough literature has grown up to be embodied in a book originally written in German by two Hungarian scientists, Prof. Zechmeister and Dr. Cholonoky which underwent two editions, the last appearing in July 1938. Drs. Bacharach and Robinson of the Glaxo Laboratories have translated the book to which Prof. Heilbron has written a short foreword. The translation is published by the well-known firm Messrs. Chapman & Hall and the book covering over 370 pages of printed matter and containing 74 illustrations is moderately priced 25*sh.*

The half-tone blocks seem to have been lent by Julius Springer of Vienna the publishers of the German edition; some of the illustrations show the presence of spots which do not interfere with their explanatory value but do reduce their artistic standard. Fig. 20, for example, has two black spots in the background and a white one on the neck of the flask. Fig. 68 again has two white spots and is moreover printed upside down as compared with the German original. The Germans write exhaustively, the French lucidly. The English translation has followed the French method by abbreviating the bibliography and omitting titles of the papers carefully given in the German original and leaving only the references to publications. The taste for clarity is very apparent in the translation. For the original "Kunsblich bereitete Porphyrin Praparate" the English edition states "Synthetic Porphyrins" which is as lucid as it is precise. Many such examples could be given which makes the translation even superior to the original. The sub-titles of smaller paragraphs are often found at the beginning of their sentences in the German book. The translators have given them the importance they deserve and printed the

headings in thicker type and by themselves at the top of each paragraph. For example the German edition says on page 185: "(*a*) Absorptions verhalten einiger *basicher Farbstoffe* ....." running in one sentence the English version prints as follows:

"(*a*) *Basic Dyes.*

The order in which a number of basic dyes ....."

The original text itself is not written in the characteristic heavy style of the Germans but the English translation makes the contents even more easily assimilable. The English rendering is so well done that the work no where reads like a translation and the meaning is everywhere more clearly expressed than in the original. Even if one were able to read German without the help of a dictionary we would recommend the English translation.

Finally we wish to endorse what the publishers communicate on the wrapper "This is the first account of Chromatography to be published in English and the first book dealing exclusively with a subject that has already proved of enormous value in different fields of research."

S. M.

PHYSIOLOGY OF RESPIRATION OF THE AIR-BREATHING FISH, *MONOPTERUS JAVANENSIS* LACÉPÈDE [=*FLUTA ALBA* (ZUIEW)]:—A REVIEW

MARKED seasonal changes, especially in regard to the alternation of dry and wet periods, in the climatic conditions of India have resulted in a number of interesting adaptations in certain fishes of the country. The most remarkable among such adaptations is the habit acquired by some forms to make direct use of the atmospheric air for tiding over periods of drought when the waters in which they live either become very stagnant or dry up altogether. Though this habit has been acquired by many species in a greater or lesser degree, depending on the environments in which they live, the end in view is the same in all cases; the means adopted for its achievement and consequently the structural modifications undergone by the various fishes belonging to widely separated families are, however, quite different. The highly interesting subject of aerial respiration in fishes attracted the attention of not only the earliest ichthylogists who investigated the Indian fauna but is still being studied by a number of students both in this country and abroad. With the advances in the technique for carrying out physiological experiments, the mass of data collected within recent years has materially helped to elucidate the nature and cause of evolution of this remarkable phenomenon. In a recent contribution on the subject, Wu and Liu (The Bucco-Pharyngeal Epithelium as the Principal Respiratory Organ in *Monopterus javanensis*, *Sinensia*, April 1940, Vol. XI, pp. 231–38), as a result of direct observations and a series of illuminating experiments, have been able to establish that in *Monopterus javanensis* the bucco-pharyngeal epithelium serves as the principal respiratory organ, both in air and water; they have also been successful in elucidating the exact rôle of the gills and the skin in this vital process. Finally the authors studied the morphological features of the branchial apparatus of the fish with a view to ascertaining the rather limited function of the gills and the capacity of the fish for cutaneous respiration.

Wu and Liu describe in detail the mode of respiration of *Monopterus* and show that for six-tenths of the period the fish remains in a state of suspension, three-tenths in the aerial phase of respiration, and only one-tenth in the aquatic respirating phase. They fully support the reviewer's views (Physiology, Bionomics and Evolution of the Air-breathing Fishes of India, *Trans. Nat. Inst. Sci. India*, 1935, Vol. I, pp. 1–16) with regard to the less laborious nature of the aerial as compared with the aquatic respiration, higher efficiency of the aerial respiration in obtaining oxygen and, in consequence, only a small expenditure of energy on the part of the animal adopting this mode of obtaining air. From the results of their elaborate experiments on the efficiency of

the aquatic respiration in *Monopterus*, the authors conclude that "provided the supply of dissolved oxygen is sufficient, *Monopterus* can live under water indefinitely". In this respect also, the reviewer's (Physiology of Respiration and Evolution of Air-breathing Fishes, *Proc. Nat. Inst. Sci. India*, 1939, Vol. V, pp. 281–87) experimental data are fully supported by the Chinese workers. It is, however, remarkable to note that Das [Nature and Causes of Evolution and Adaptation of the Air-breathing Fishes (A resume), *Proc. 27th Ind. Sci. Cong.*, 1940, pp. 215–60] still holds that under no circumstances branchial respiration alone is quite sufficient for the maintenance of life in the case of the air-breathing fishes of India. A series of experiments undertaken by Wu and Liu to determine the chief organ of aquatic respiration of the fish—since the gills are greatly reduced—showed that whereas respiration by the gills and the skin could not maintain its life, that by the bucco-pharyngeal epithelium can. Thus it has now been experimentally demonstrated, what was pointed out by the reviewer in 1935, and reiterated in 1939, that aquatic and aerial respiratory surfaces are capable of interchanging their functions. The structures of the branchial apparatus and the skin of *Monopterus* are described and the general conclusion is reached that:

"The gill of *Monopterus* is rudimentary inasmuch as the respiratory area has been greatly reduced. It has been proved to be physiologically dispensable, and the fish is likely to be 'drowned' if it depends solely on its gills for respiration. The skin possesses little histological specialization to facilitate the exchange of gases, and its capacity for cutaneous respiration is necessarily of meagre extent. The bulk of the work of respiration falls upon the bucco-pharyngeal epithelium, which now becomes the principal respiratory organ in function. Though habitually employed as the organ of air-breathing, the bucco-pharyngeal epithelium proves effective for aquatic respiration also, and by means of which *Monopterus* is able to live almost indefinitely under water or in air without the aid of gills, provided suitable physiological conditions are established. Structurally the bucco-pharyngeal epithelium is very simple and generalized on the whole, but it seems to be a perfect adaptation in itself, and its utility is even greater than the pharyngeal 'lung' of an allied fish, *Amphipnous cuchia* ....."

S. L. HORA.

CENTENARIES

Common, Andrew Ainsle (1841-1903)

ANDREW AINSLE COMMON, a British astronomer, was born at Newcastle-on-Tyne August 7, 1841. Owing to his father's premature death, he joined his uncle in a firm of sanitary engineers in London. But even as a boy of ten he had shown an interest in astronomy and when he settled in London, he revived this interest and set up a telescope in his house in 1874 and joined the Royal Astronomical Society.

By 1878 he had made sufficient observations with a silver-on-glass mirror of eighteen inches diameter to contribute a paper on the *Satellites of Mars and Saturn*. After five years of hard work, he completed in 1886 a five-feet equatorial reflecting telescope which was later taken over by the Harvard College Observatory. He made several mirrors and presented some to the Royal Society to make observations on the eclipses and some bigger ones to various other observatories.

Common was a pioneer in the application of photography to heavenly bodies. For he was practically the first to develop and describe its possibilities in a paper published in the *Monthly Notices* in 1879. In 1881 he photographed the great comet of that year. This is the first recorded photograph of a comet. In 1882 he took a magnificent photograph of the great nebula of Orion. Thus he opened the way for further strides in astrophysics.

As a mark of appreciation of his successful attempt at astronomical photography, the Royal Astronomical Society awarded its gold medal to Common in 1884. He was elected F.R.S. in 1885 and became its president during 1895–97. He became an LL.D. of St. Andrews in 1891 and became the first president of the Astronomical section of the British Association which was formed in 1900. His address gives an elaborate history of the construction of astronomical instruments in the nineteenth century including his own work on reflecting telescopes. His address contains the prophetic statement "Photography also comes in as a further aid to the telescope, as it may possibly be to the microscope".

Common died suddenly of heart failure at his house at Ealing June 2, 1903.

S. R. RANGANATHAN,
University Library,
Madras.

OBITUARY

DR. RABINDRANATH TAGORE (1861–1941)

WE deeply mourn the death of Rabindranath Tagore on Thursday the 7th August in his residence at Calcutta. He was a universal figure venerated all over the civilised world as a poet, a philosopher and a seer. He travelled far and wide, and in most cities of the world, surging crowds were held spell-bound by the melody of his voice, by the inspiration of his addresses and by the fullness of his love and sympathy. There is scarcely any language into which his more important verses have not been translated. No poet, ancient or modern, has received during his lifetime the honour and reverence with which Dr. Tagore has been greeted both in the East and the West. Indeed Keyserling has aptly described him as the most encompassing human being ever known.

His literary achievement is prodigious. It overshadows everything else. His writings have influenced the cultural and spiritual life of Bengal as nothing else has done during the last fifty years. He is however essentially a lyrical poet; and his poems have a universal appeal for they are always the expressions of his unique personality. As he himself says, "When our heart is fully awakened in love or in other great emotions, our personality is in its flood tide. Then it feels the longing to express itself. Then it is that the notes of our music and song try to fathom the depths of the ineffable." Thus when *Gitanjali* was published in English translation in 1912, it was received with raptures that were almost bewildering. Maeterlinck thought that the passages in that book would rank among the loftiest, the most profound and most divinely human ever written. And he was soon awarded the Nobel Prize in Literature.

Rabindranath is also justly famous in the rôle of a teacher of youth. The memory of his own school days was unhappy. A method of discipline which refused to take account of the individual and was designed for grinding out uniform results was repugnant to his whole temperament. It was fortunate that he was allowed to study at home in his own way. It is this unhappy memory of his childhood which prompted him to break new ground and establish an "Ashrama" in the rural surroundings of Santiniketan. He always wished that the young mind should be saturated with the idea that it has been born in a human world which is in harmony with the nature around it. The highest education is that which does not merely give us information but brings us up in harmony with all existence; and visitors to Santiniketan will never forget the early morning song which wakes them up from sleep—the boys singing in chorus and praying that they might expand into love of nature, of beauty and of God. He never had any feelings of distrust about the boys' capacity of understanding. No songs he would give to the outer world until he has sung it himself to his juvenile audience. All his plays must first be staged in Santiniketan by the boys and the girls of the Ashrama acting under his own direction. No pronouncement on the burning topics of the day, but the first listeners will be the disciples in the Ashrama. He held very high this ideal of education through sharing a life of high endeavour with one's master, —the teacher prosecuting his own studies, living a life of simplicity and helping the students in their lessons as a part of his life and not of his profession. In Santiniketan he recaptured for himself the meditative calm of ancient India and lived in the tradition of our ancient rishis.

There are few people who now remember that in the first decade of this century, Rabindranath was an active participant

in the rough and tumble of politics. His national songs were sung in almost every political demonstration that followed the partition of Bengal in 1905. His eloquent speeches in Bengali moved vast audiences to whom the English oratory of Surendranath Banerjee carried no meaning. He became a priest of the National Revival and assailed foreign rule with increasing vehemence. He extolled the valour and self-reliance of the heroes of India in most exquisite ballads, which together with his national songs have become a priceless possession of the Bengali literature. But when in the wake of this revival of political consciousness, came the cult of the bomb for recovering national freedom, Rabindranath withdrew from active politics. He strongly felt that this cult of terrorism was fundamentally opposed to the spirit and teachings of our sages. And when Mahatma Gandhi began preaching his plan of winning freedom through non-violent conscious suffering, Dr. Tagore accepted this doctrine with alacrity and gave expression to it in magnificent words:—

"I hope the spirit of sacrifice and willingness to suffer will grow in strength. For to achieve this is an end in itself. This is the true freedom. Nothing is of higher value, be it national wealth or independence, than disinterested faith in the moral greatness of man. The West has its unshakable faith in material strength and prosperity. And therefore however loud grows the cry for peace and disarmament, its ferocity growls louder. We in India shall have to show to the world what is that Truth which not only makes disarmament possible but turns it into strength. Life, in its higher development, has thrown off its tremendous burden of armour and a prodigious quantity of flesh till man has become the conqueror of the brute world. The day is surely to come when the frail man of spirit completely unhampered by arms, airfleets and dreadnaught will prove that the meek is to inherit the Earth. The destiny of India shall choose for its ally Narayana and not Narayanasena, the power of soul and not that of the muscle. Our fight for Swaraj is also a spiritual fight. We are to emancipate Man from the meshes that he himself has woven round him—these organisations of National Egoism. The butterfly will have to be persuaded that the freedom of the sky is of higher value than the shelter of the cocoon. If we can defy the strong, the armed, revealing to the world the power of the immortal spirit, Man will find his Swaraj; and in winning such freedom, we shall win freedom for all humanity."

One cannot help recalling that Rajah Ram Mohan Roy, the father of modern Indian Renaissance, had Maharsi Devendranath Tagore as his foremost disciple and Rabindranath was the youngest son of that disciple. Rarely do we witness such a succession of greatness in the history of a country to mould the spiritual and national life of its people for more than a century. These were noble spirits who were called to surrender themselves to the quest for the Heaven of Truth and Freedom. When the chaos of the modern world would burn deep his sensitive soul, Rabindranath would sing:

"Where knowledge is free,
Where words come out from the depths of Truth
Where the clear stream of Reason has not lost its way into the desert sand of dead habit,
Unto that Heaven of Truth and Freedom, my Father, let my country awake."

To readers of *Current Science*, what message could be more inspiring than the call to join this quest!

INTER-UNIVERSITY BOARD, INDIA
ANNUAL REPORT, 1940-41

THIS Annual Report of the Inter-University Board indicates the action that has been taken in regard to the various resolutions passed by the Board in previous years and it also refers to the correspondence that has taken place on certain important questions of common interest to universities. Reference may be made in this review to some of the outstanding matters contained in the Report.

The question of providing separate courses of study for women candidates in the universities had been recommended by Resolution XII of the Board at its Waltair Session. But from a glance at the replies received from the various universities in this connection it would appear that opinion is somewhat sharply divided. Some universities evidently consider it undesirable to make any difference between men and women in regard to the degree courses. Some others seem to think that differences may be made in the diploma courses only. Still others express no opinion at all. Only two or three are altogether in favour of the proposal. Again, a few would content themselves with the inclusion of only one or two subjects which may be of special interest to women, but would go no farther.

It is difficult to understand why there should be so much difference of opinion when once it is conceded that men and women have different rôles to fulfil in life and that they therefore require differential training. But it is probably feared that the subjects proposed for women may not be of a sufficiently intellectual character for being included in university courses on terms of equality with the other subjects. It must be remembered, however, that much depends upon the manner in which these subjects are dealt with in the classroom. Another objection may come from the women themselves who may look upon their special subjects as inferior to the usual academic studies in point of the mental discipline which they provide. This difficulty may be avoided, to some extent, by offering free choice to the women. If this is done, it is likely that the inferiority complex may disappear in course of time. Whatever the difficulties may be, there is no reason why universities should hesitate to take a step which is obviously in the right direction.

A second important question relates to the forming of a film library suitable for university purposes. The value of cinema films in all stages of education is being increasingly recognized in these days. In U.S.A. educational films have been carefully and extensively developed in recent years; and, but for the war a similar expansion would also have taken place in Europe. India is a poor country, and the setting up of a film library for university use must therefore be a co-operative enterprise. It is therefore gratifying to note that almost all the universities in the country have expressed their willingness to take part in the venture.

The resolution inviting the co-operation of Indian universities in the work of adult education in this country has evoked a variety of replies, mostly unfavourable. The problem in India is not on a par with what is described as the problem of adult education in the advanced countries of the West. There, it is a question of giving further education to those who have already had elementary schooling; whereas here in India it is a question of promoting literacy among those who never went to school. The appropriateness of universities undertaking this latter task must remain an open question. If, on the other hand, the co-operation of the universities is requested for what corresponds to the University Extension Movement in England, then the matter certainly deserves support.

Lastly, the proposal for exchange of professors as between universities has been regarded favourably in most quarters; but some universities have expressed doubt as to its practicability. It is to be hoped, however, that the practical difficulties will soon be overcome and a workable scheme will soon be put through. There is no doubt that exchange among university staff will let in some fresh air into lecture halls whose atmosphere often tends to deteriorate for want of renewal.

D. S. GORDON.

SCIENCE NOTES AND NEWS

A Hymenopterous Parasite.—*Probaryconus indicus* (Kieff.) recorded for the first time from India.

Mr. P. V. Isaac, Imperial Agricultural Research Institute, New Delhi, writes:—

While examining sugarcanes for insect pests at the Agricultural College Farm, Poona, during April 1941, a few leaves with midribs having reddish-brown irregular patches on the upper surface were noticed. On splitting open such patches, grubs of a hymenopteron were found inside a smooth cell. These grubs pupated inside the cell as naked pupæ. The adult wasps emerged out through holes on the under-surface.

The specimens are found to be *Probaryconus indicus* (Kieff.), not so far recorded from India. It was originally described by Kieffer (*J.J. Zeitschr.* Hymen. Dipt. VII, 1907, p. 311) from Java. No host of this parasite is mentioned by him. No other information is available about this insect. The group of parasites to which this belongs, the Proctotrypoidea, are known to attack the eggs of Orthoptera, especially of Acrididæ and Locustidæ. Very likely this wasp, collected in Poona, is parasitic on the eggs of some Locustid which lays its eggs inside the midrib of sugarcane.

Permeability in Monolayers.—A modified form of evaporant has been employed by Sebba and Rideal (*Trans. Far. Soc.*, 36, 273) to measure the rate of diffusion of water through monolayers of simple and complex films. The permeability ratio for water with various films supports the hypothesis that the rate of diffusion of water through the film depends more on the proportion of water in the film itself than on the physical state of the film. The permeability ratio has also been determined using solutions of alcohol and ammonia in water. The evaporation of both alcohol and ammonia is retarded by the monolayers. It is interesting to note that the extent of evaporation depends upon the spreading liquid in which the film-producing substance is dissolved.

M. R. A.

Relation between Nitrogen Deficiency in Soils and the Accumulation of Tannins in the Cotton Plant.—In the course of the investigations into the cause of periodical failures of the American cotton crop in the Punjab by Dastur it may be recalled that the presence of tannins was noted as peculiar to the leaves of this cotton suffering from the yellowing and shedding of the leaves characteristic of the disease. In the course of further investigations it has been found that such accumulation of tannins is connected with a deficiency of nitrogen in the soil (R. H. Dastur, *Ind. Jour. Agr. Sc.*, Vol. XI, Part II). Nitrogenous manuring increased the nitrogen content of the leaves as against controls not so manured, and in the leaves having a higher nitrogen content tannins were absent. The border line figure for the nitrogen content deciding the presence or absence of tannins was found to be about 2·5 per cent. of the dry matter of the leaves, the tannins developing if the figure goes below this level. The test for tannin is to be made when the plant is in the flowering stage and if a positive result is obtained at this stage then it may be taken as a biochemical index of the deficiency of nitrogen in the plant. The practical value of this observation lies in the fact that the nitrogen content of the leaves can be increased by nitrogenous manuring. Where a positive test for tannins is obtained when the plant is in the flowering stage an application of sulphate of ammonia is found to greatly increase the yield and to improve the opening of the bolls. If however the soils rest on a saline sub-soil then these results do not apply. In the Punjab soils the outward appearance of the plants on such soils is sufficiently distinctive of the character of the soil and this can be taken as a reliable test to decide about applying sulphate of ammonia, even though the leaves give a positive test for the presence of tannins. These results have been confirmed by experiments conducted on the cotton fields of private cultivators also. It may be noted that even apart from the relationship of tannins to nitrogen content, nitrogenous manuring brings about a certain degree of mitigation of this disease.

A. K. Y.

Mr. Zal R. Kothavalla who has been appointed Officiating Director, Dairy Research, in succession to the late Dr. W. L. Davies, in addition to his own duties as Principal and Animal Husbandry Officer, Bangalore, is a well-known scientist, who, as Imperial Dairy Expert, did considerable work for advancing Dairy Research in this country. A number of his papers on Dairying and Dairy Products have appeared in the *Indian Journal of Veterinary Science* and other journals. He was born in 1896; after passing (1918) the B.Ag., of the Bombay University with specialization in Animal Husbandry and Dairying, he took the B.Sc. (Agr.) degree of the Edinburgh University and N.D.D. of Scotland (1921). He held the posts of the Dairy Superintendent of the Bombay Municipality (1922–25); Assistant to the Imperial Dairy Expert, Bangalore (1925–32), and the Imperial Dairy Expert (1932–41). He attended the ninth International Dairy Congress, Copenhagen, in 1931 as the official delegate from India.

India: 1,000 Years Ago.—The Archæological Survey of India has salvaged from oblivion a work, pieced together from various sources, bearing on the physical, cultural and scientific progress of India and its contiguous countries about a thousand years ago by the world-

renowned oriental scholar, Al-Biruni, in the form of a Monograph in Arabic.

This reputed savant (whom Sir Aurel Stein considered the Leonardo da Vinci of the eleventh century) was one of the luminaries in the court of Sultan Mahmud of Ghazni and had extensive opportunities of obtaining first-hand knowledge of the geography of the different lands of Asia and, being a linguist of rare ability, he had an intimate knowledge of the languages, sciences, literature, philosophy, religion and beliefs of the races amongst whom he mixed freely.

The results of his observations are embodied in his monumental work entitled "al-Qanun al-Mas'udi". This monograph, which has just been published by the Archæological Department, is an epitome of such portion of the work as deals mainly with the physical geography and mineralogy of India.

The monograph is arranged in four chapters. In the first chapter the author describes the condition of the earth in general and the geographical division of the countries in particular in relation to their latitude and longitude, illustrated by a tabular statement.

The second chapter is devoted to the genesis of the world, of primeval man and of the glacial theory, which was apparently conceived by this great scholar for the first time, as early as the eleventh century, on the evidence existing on the hilltops of Yemen (Arabia) and their neighbourhood, of fossils and fossilised bones, generally associated with aquatic animals. In the third chapter mention is made of precious and semi-precious stones and other minerals such as gold, silver, copper and iron together with their location and mode of acquisition.

The fourth and last chapter deals with (*a*) the vegetable world, *viz.*, herbs, plants, fruits, drugs, barks together with their properties, usefulness and location and (*b*) the animal kingdom, both aquatic and terrestrial, with their characteristic nature and mode of life.

The editor, Zeki Validi Togan, a Turkish oriental scholar, wandered at large in search of Al-Biruni's invaluable works and salvaged them from different quarters of Europe and Asia. He then set himself to work on them and, after labouring hard for several years, prepared this monograph. After trying in vain to find a publisher on the Continent, he approached the Director-General of Archæology in India, who, in appreciation of the merit of the work, decided to publish the text in advance of the English translation.

Swat Valley Expedition.—The Archæological Survey of India has issued a monograph compiled by Prof. Evert Barger and Mr. Philip Wright, who along with Mr. T. D. Weatherhead, explored the Swat Valley and the Oxus territories of Afghanistan in the summer of 1938. The expedition was led by Prof. Barger. The object of the expedition was to trace the spread of Buddhism and hellenistic art from India, across Pamirs and the Tarim Basin, to China. "Our object in organising this expedition was a modest one. We wanted to call attention to these problems, and, by adding something to the scattered raw material, to revive the study of a subject to which British enterprise has not contributed much since the Great War outside the administered frontier of India."

The lands between the Oxus and the Indus form one vast canvas which must be studied as a whole and which was the meeting ground of three great civilizations, *viz.*, those of India, China and the Graeco-Roman civilization of Western Asia, during the centuries between Alexander's Eastern expedition and the Islamic invasion. The Barger expedition has broken new ground in exploring the country north of the Hindu Kush, where they have explored a large number of sites in Wakhan. The discovery of hellenistic stone columns of Corinthian style at Kunduz near the Oxus is of considerable interest, as such remains have never been found north of the Hindu Kush.

In the Swat region, the British expedition excavated several sites in the Barikot District, the more important being the stupa at Kanjar Kote and the Buddhist remains at Gumbat, Amluk and Abarchinar, all on the left bank of the Swat.

Professor Barger writes: "The first tidings of Amluk, a site which had not been made known to Sir Aurel Stein, were brought by shepherds who took their buffaloes to that remote mountain top for summer pasture. These men had never seen a white man before. Until rumour reached them of our camp at Barikot and our quest for *buts* (idols), their only contact with European civilization had been the occasional passage of an aeroplane over their eyrie.

"Our work at Barikot had two distinct, though closely related objects. The first was a survey, as comprehensive as possible, of all ancient remains both in the three side valleys and on the right bank of the Swat river. The map which was made attempts to show not only the existing remains of stupas, monasteries and fortresses, but also those of some of their dependent villages and terraced cultivations, dead for fifteen hundred years. It was our hope that in this way it might be possible to determine the area of settlement, and the relation between domestic remains and areas of cultivation to see, in fact, what this small area looked like in Buddhist times.

"Our second object was to excavate a number of sites, not so much with a view to collecting sculpture and museum pieces, as to estimate the relation of different pieces of sculpture to one another, to examine the archæological context in which they are found, to establish the main types of sculpture in Swat and to determine, if possible, the relation between specific pieces of sculpture and domestic objects—coins, seals, ironwork or terracottas, which because of their appearance elsewhere in a dateable contest, might help to provide the beginnings of an archæological chronology of Gandharan Art.

"Two or three more general problems must always be at the back of the mind of the archæologist who turns to these frontier regions; why it was that such a virile, hybrid,

local art sprang up in a comparatively small area in these rocky foothills, and spread, undergoing some modification on the way, to Afghanistan and Chinese Turkistan; how such a large population—Hiuen Tsiang speaks of 1,400 monasteries and 18,000 monks—was supported in these bare, now almost waterless valleys; how and when the monasteries came to be abandoned and destroyed."

Earthquakes in the Hindu Kush Region.—A note published by the Indian Meteorological Department discusses the results of a special study of the seismological features of the strong earthquake which occurred on November 21, 1939 (at 16 hr. 31 m. 43 s. I.S.T.) in the Hindu Kush mountains.

The shock caused some structural damage at Gilgit and Srinagar and was felt with varying intensities over the whole of Kashmir State, North-West Frontier Province, Afghanistan and the north Punjab. Lahore appears to be the farthest place from the epicentre to experience the shock.

This study is based on instrumental data collected from 32 stations of the world and seismograms from the five Indian observatories and Colombo. The epicentre of the shock is located at latitude 36 degrees 11 minutes North and longitude 70 degrees, 53 minutes East in the Hindu Kush mountains, near the border of Chitral State in Afghanistan. The depth of focus is calculated about 130 miles below the earth's surface. These results are in agreement with those of the previous deep earthquakes from the same region.

Some characteristic features observed in the seismograms of this shock were found present with marked similarity in the case of the previous deep quakes from this region. Seismograms of deep earthquakes are in general more complicated and location of their epicentres more difficult than those of normal ones. But in the case of the Hindu Kush shocks it is possible to get reliable information as to their origin from the seismograms of any one Indian station.

Another remarkable aspect of the deep shocks from this region is that they are distributed in a small area round about the point 36·5 degrees North and 70·5 degrees East, from which position alone as many as 22 shocks are reported to have originated in the past 20 years. A statistical analysis shows that these shocks occur at the rate of two per year and that the strong ones exhibit a marked tendency to originate in winter. Of late, the seismic activity of the Hindu Kush appears to be on the increase.

Titanium Ore is finding increasing use in the American industry and, India by far the world's largest producer of this ore, is the United States' main source of supply.

Titanium ore, in the form of ilmenite in India, is found in association with monazite from which thorium nitrate, used in the manufacture of incandescent gas mantles, is derived and titanium ore was formerly considered a by-product of the monazite industry. In recent years, however, it has become more important than monazite because of the demand for its contents of titanium oxide in the manufacture of titanium paints.

Titanium ores which are useful primarily because of their whitening and obliterating powers are used in the United States not only in the paint industry—their main use—but also in the rubber, linoleum, leather, plastic, soap, printing ink, textile, ceramic and ferro-alloy industries.

Studies of Clouds.—During the last two years systematic researches have been carried on at Poona by taking photographs of some types of natural clouds at short intervals of time. The various changes thus observed confirm a number of points brought out by experiments on artificial clouds. This forms the subject of a paper just published by the India Meteorological Department (*Scientific Notes*, Vol. VIII, No. 94) in which some of the selected series of photographs are reproduced.

The movement and appearance of clouds give us valuable information about the physical conditions of the atmospheric layers in which they are embedded. Apart from the routine observations, such as the measurement of height, velocity and direction, total amount, kind, etc., of clouds at the time of observation at a meteorological station, special studies are in progress at different places. In recent years, for example, artificial clouds have been produced in the laboratory and their movements under conditions resembling those in the atmosphere are watched and recorded carefully. The clouds thus produced greatly resemble in form and pattern, the natural clouds.

Census of Essential Drugs.—With a view to maintaining a check on the import, manufacture and sale of essential drugs, a new Order has been promulgated by the Central Government under the Defence of India Rules. The Order is called the Essential Drugs (Census) Order, 1941, and is to come into force at once.

In accordance with this Order, any person engaged in the business of manufacturing, importing or selling such drugs, whether wholesale or retail, is required to submit to the authority specified for his area, so as to reach that authority not later than the 27th day of each month, a return showing the quantity of any essential drug in his possession or under his control within British India on the 20th day of such month. No return, however, is required to be submitted if the total quantity of any essential drug in the possession or under the control of any person is less than that specified in the Order.

Every manufacturer, importer or dealer in drugs, whether wholesale or retail, is required to keep a record of the purchase or sale of any quantity of an essential drug made by him, whether such quantity is less than that specified or not. No record of such transactions, however, need be kept by a retailer if the total quantity of an essential drug in his possession or under his control is less than that specified.

The correctness of any return submitted or record kept in pursuance of this Order is subject to verification by any person authorised by the Central or the Provincial Government for this purpose. The person so authorised will have the right to enter and inspect the premises of any manufacturer, importer or dealer and to inspect and take copies of any records, books or accounts kept in connection with such business.

The following are the authorities specified for receiving the returns in the various areas:—

Madras, the Central Provinces and Berar, and Coorg—The Deputy Assistant Director General (Medical Stores), Madras.

Bombay Presidency, Sind and Ajmer-Merwara—The Deputy Assistant Director General (Medical Stores), Bombay.

Bengal Presidency, Bihar, Orissa and Assam —The Deputy Assistant Director General (Medical Stores), Calcutta.

United Provinces, the Punjab, North-West Frontier Province and Baluchistan—The Deputy Assistant Director General (Medical Stores), Lahore.

According to a Press Note from the **Supply Department** the first stage in making India self-sufficient in the manufacture of high explosives has been reached by the production of pure toluene for nitration at a newly erected toluene plant.

Another notable development is that basic steel manufactured by acid process from 100 per cent. scrap is now being made by an engineering works. It is anticipated that this will relieve the shortage of spring steel required by the Railways which had hitherto been imported.

Electric Grid Scheme for Orissa.—An electric "grid scheme" for the Province of Orissa is under investigation. The sources of power are hydro and thermal energy as hydro-electric power is available for South Orissa while for North Orissa cheap coal may be obtained.

Two possible hydro-electric sites are the Bogra Falls of the Kolab river, about 11 miles from Jeypore, and the Duduma Falls of the Machkand river, about 40 miles from Jeypore —both in the Koraput District. The Kolab River Scheme consists of a dam storing about 2,200 million cubit feet of water for a peak load of 72,000 K.W. and continuous load of 36,000 K.W. under a gross head of 611 feet.

The whole scheme would cost about Rs. 3,75,00,000 excluding transmission lines and substations. As, however, such an immense load will not be available within economic distance of the falls in the near future, a modified scheme, which will have a maximum installed capacity of 18,000 K.W., is under consideration.

From the Duduma Falls it is possible to obtain a drop of about 830 feet at a minimum continuous flow of nearly 150 cusecs and it appears from preliminary investigation that the civil engineering portion of this scheme may be slightly less than that of the Kolab Scheme.

The preliminary survey so far carried out shows that ample load will be available within economic distance of transmission from the proposed sites and it appears that one more paper mill may be run economically in the district.

World Consumption of Jute.—The Indian Central Jute Committee has just issued an important brochure entitled "World Consumption of Jute, 1938–39 and 1939–40" (*Economic Research Bulletin No. I*). This publication has brought together much valuable statistical material on jute trade and industry and gives various estimates that are not available elsewhere.

"Reliable estimates of the total consumption of jute in the world are given in this *Bulletin* for the period from 1933–34 to 1939–40. They show how this figure reached its peak in the year 1936–37, when an aggregate consumption of about 123 lakhs of bales was reached, and how in spite of the hectic buying at the beginning of the war, the total world consumption of jute in 1939–40 fell considerably short of this peak figure. Independent estimates of the yield of the jute crop are also given for the 1938–39 and 1939–40 seasons. The *Bulletin* also embodies the results of important investigations carried out by the Economic Research Sub-Section of the Committee in connection with the estimation of the world consumption of jute. These cover a number of important subjects, such as the trend of Indian jute mill production as compared with that of world industrial production, changes in the jute export trade, effect of war on the consumption of jute, etc.

"An interesting feature of the *Bulletin* is an attempt to give a general idea of the extent of jute consumption in the 1940–41 season on the basis of the demand for jute in the first few months of the season. The brochure concludes with a forecast that the consumption of jute in 1940–41 will be abnormally low."

Indian Central Cotton Committee.—The monsoon meeting of the Committee was held on the 18th and 19th July 1941, Mr. P. M. Kharegat, C.I.E., I.C.S., Vice-Chairman of the Imperial Council of Agricultural Research, presiding.

The progress reports of the several agricultural schemes financed by the Committee during the past year were reviewed and recommendations made regarding future lines of work. The extension of the Broach and Jalgaon Cotton Breeding Schemes, the Wilt Cotton Breeding Scheme, Poona, the Scheme for the improvement of Wagad cotton at Viramgam and Jagudan, the Cotton Genetics Research Scheme, Indore, and the Mysore (*Doddahathi*) Cotton Scheme were sanctioned.

Among the new schemes considered and approved were the scheme for the Improvement of Dharwar-American Cotton, two marketing survey schemes—one for the Madras Province and the other for Gujarat and the adjoining Agencies and States of Kathiawar and South Rajputana—and a Model Projects Scheme for the extension of improved methods of cultivation in the Rohilkhand and Kumaon Circle of the

United Provinces. The Committee also recommended the appointment of a co-ordinating Cotton Botanist for the Province of Bombay.

Among other questions that engaged the attention of the Committee, mention may be made of the following:—The establishment of an export organisation for extending the use of Indian cotton goods in other countries; alternative uses for short-staple cotton; and improvement of cotton forecasts. The annual report of the Technological Laboratory for the year ending May 31, 1941, was approved.

Medicinal Drugs and Chemicals.—The Bombay Government have arranged for the production of the following medicinal drugs and chemicals, under the guidance of their Industrial Research Chemist, to meet the large demands of the Supply Department: Phosphorus, tartaric acid, potassium perchlorate, iodine, strontium carbonate and carbon bisulphide.

Display of Indigenous Products.—According to a press note, issued from the Supply Department of the Government of India it has been decided to establish sample rooms at six Provincial centres with the Controllers of Supplies, Calcutta, Madras, Bombay, Karachi, Lahore and Cawnpore. It is proposed to establish a sample room at New Delhi as well.

In all these sample rooms it is proposed to display (1) such articles as are at present not produced in India but demand for which exists; (2) articles not being produced in sufficient quantities in India to meet the demands in full; (3) articles previously exclusively produced by ordnance factories at the various centres but which are now proposed to be transferred to trade production.

An Officer on Special Duty has been appointed to organise the establishment of the sample rooms and arrangements are being made for specified samples of articles required by the Defence Services to be provided.

Granite Rollers in Soap Making.—It is well known that toilet soap manufacturers use either granite rollers or steel rollers in the milling processes. On account of war and the consequent difficulties some of the users of the granite rollers have found it difficult to import the same from abroad.

Recently a big paint manufacturing firm in Calcutta who use granite rollers in their paint industry were faced with the same difficulty and they experimented with granite found in the State of Mysore. These have given complete satisfaction.

Information regarding these rollers may be had from Messrs. Narayanaswamy & Son, Lakshmipuram, Mysore.

ASTRONOMICAL NOTES

The Sun will be at the autumnal equinox on September 23, 1941, at $16^h\ 30^m$ I.S.T.

Eclipses.—Two eclipses will occur during the month;

(1) a partial eclipse of the Moon on September 5, 1941, the circumstances of which are as follows:—

Moon enters umbra	$10^h\ 49^m$	p.m. I.S.T.
Middle of Eclipse	$11^h\ 17^m$	„ „
Moon leaves Umbra	$11^h\ 45^m$	„ „

The magnitude of the eclipse will be 0·06 (taking the Moon's diameter to be unity).

(2) a total eclipse of the Sun, which will be visible generally as a partial eclipse throughout India except in the extreme south. The path of totality commences near the Caspian Sea in Russia and passing through Turkestan, Central Asia and China ends in the middle of the Pacific Ocean.

	Madras	Bombay
Eclipse begins	$8^h\ 16^m$	$7^h\ 50^m$
Greatest phase	$8^h\ 50^m$	$8^h\ 35^m$
Eclipse ends	$9^h\ 26^m$	$9^h\ 24^m$
Magnitude of partial phase	0·08	0·23

Planets during September 1941.—Mercury is in the evening sky but will be too close to the Sun and cannot be seen well, except during the last few days of the month. Venus continues to be an evening star; it is increasing in brightness and will set about a couple of hours after the Sun. Mars will rise an hour after sunset and is steadily becoming brighter, its stellar magnitude being −2·3 at the end of the month; the planet is stationary on September 6 when it commences to move in a retrograde direction among the stars along the southern border of Pisces. Mars will be the most prominent object in the night sky during the month.

Jupiter will be in quadrature with the Sun on September 13; it rises about midnight and will be a conspicuous object (magnitude −2·0) in the eastern sky during the second half of the night. Saturn is stationary on September 11 when it begins to move westward among the stars in the constellation Taurus. The ring system continues to widen, the angular dimensions of the axes of the ring ellipse being 43″·2 and 17″·5. About three or four degrees to the north-east of Saturn is Uranus which reaches a stationary point on September 5, and starts moving in a retrograde direction a little to the south-east of the well-known star cluster Pleiades. Among occultations of some interest that can be observed in this country may be mentioned that of the star ρ Sagittari (mag. 4·0) on September 1, and that of the first magnitude star Aldebaran (α Tauri) at about midnight on September 12. T. P. B.

SEISMOLOGICAL NOTES

During the month of July 1941 seven slight earthquake shocks were recorded by the Colaba seismographs as against one slight and three moderate ones recorded during the same month in 1940. Details for July 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.	Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
July 1941—		H. M.	(Miles)		(Miles)	
2	Slight	08 12	1450			
9	Slight	06 09	1550			
14	Slight	07 32	1450	11°·7 N., 93°·0 E., near the Andaman Islands		Apparently the after shocks of the very large earthquake of June 26, 1941
18	Slight	05 01	1500			
22	Slight	01 49	1450			
24	Slight	19 23	3550			
27	Slight	01 42	4700			

ANNOUNCEMENTS

Register of Chemists.—An All-India Register of Chemists is being prepared by the Indian Chemical Society. All chemists employed or unemployed are requested to have their names enrolled in the Register of Chemists in the prescribed form. Such a register will be of immense service and value to all interested in the chemical profession and trade, and also in the employment of chemists as a source of ready reference. The unemployed chemists will find it useful to register their names as the Society intends to put them in touch with employers whenever occasion arises. No fees are demanded for registration. Necessary forms will be sent on application to P. K. Bose, Hony. Secretary, Indian Chemical Society, P.O. Box No. 10857, Calcutta.

The next meeting of the **Inter-University Board, India**, will be held at Chidambaram on January 6–7, 1942.

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4586–87.

"Agricultural Gazette of New South Wales," Vol. 52, Pts. 5–6.

"Indian Journal of Agricultural Science," Vol. 11, Part 3.

"Indian Forester," Vol. 67, Nos. 7–8.

"Indian Farming," Vol. 2, No. 7.

"Indian Medical Gazette," Vol. 76, No. 7.

"Journal of the Indian Botanical Society," Vol. 20, No. 4.

"Journal of the Indian Chemical Society," Vol. 18, No. 4.

"Nature," Vol. 147, Nos. 3731–33.

"The Philippine Journal of Science," Vol. 74, Nos. 1–3.

"The Indian Journal of Physics," Vol. 24, Part 1.

"Proceedings of the Royal Society of Edinburgh," Vol. 60, Part 4.

"Canadian Journal of Research," Vol. 19, No. 4.

"Sky," Vol. 5, No. 8.

"Science and Culture," Vol. 7, No. 2.

"Ceylon Journal of Science," Vol. 3, Part 2.

"The Indian Trade Journal," Vol. 142, Nos. 1829–33.

Books

"Sons of the Soil," edited by W. Burns. (Manager of Publications, Delhi), 1941. Pp. 128 + 44 plates. Price Rs. 2–6 or 4*sh.*

"Anthropological Papers." (Calcutta University), 1941. Pp. 187.

"The Scientific Photographer," by A. S. C. Lawrence. (Cambridge University Press), 1941. Pp. x + 180. Price 18*sh.*

"Reports on Progress in Physics," Vol. VII, edited by J. H. Awbery. (The Physical Society, London), 1941. Pp. 1 + 362. Price 22*sh.* 6*d.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

July 1941, SECTION A.—P. G. N. NAYAR: *The luminescence, absorption and scattering of light in diamonds. Part III. Absorption.* The features of the absorption in diamond observed by the author and earlier workers are shown to be inconsistent with the electronic energy levels obtained from the theoretical calculations of Kimball. Thus crystals do not actually conform to the ideal lattice, and a certain secondary structure brings about new intermediate levels. KANTILAL C. PANDYA AND P. GEORGE VARGHESE: *The condensation of aldehydes with amides. Part VII. The condensation of Piperonal.* KANTILAL C. PANDYA AND P. GEORGE VARGHESE: *The condensation of aldehydes with amides. Part VIII. The condensations of* 6-*Nitropiperinal.* P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Constitution of Butrin.* P. SURYAPRAKASA RAO: *A note on the methylation of quercetagetin.* B. R. SETH: *On Guest's law of elastic failure.* B. LAKSHMAN RAO: *Raman effect in potassium tartrate crystal.* G. V. L. N. MURTHY: *Colour analysis and colorimetry. Part I. Nitrate estimation.* B. LAKSHMAN RAO: *Raman spectra of some crystalline nitrates and sulphates.* The sulphates examined in the form of single crystals have yielded all the frequency shifts characteristic of the internal oscillations of the sulphate ion, including some of the split components of the degenerate lines and also some new lattice frequencies. P. RAMA PISHAROTY: *On the geometry of the quantum reflection of X-rays in diamond.* The appearance of quantum reflections outside the plane of incidence in cases when it is not a plane of symmetry is worked out quantitatively and the agreement with observation is a striking evidence of the definite orientation of the phase waves associated with the lattice vibrations in this case. The streamers and the two subsidiary spots accompanying the modified reflection (Raman and Nilakantan), their behaviour with changes of crystal setting, the tripling of the spots in a particular setting (Jahn and Lansdale), the changes with changes in angle of incidence—all these different phenomena are shown to be geometrical consequences of a postulate of *three* sets of phase waves. M. W. CHIPLONKAR: The brightness of the zenith sky during twilight. BRAJ KISHORE MALAVYA AND SIKHIBHUSHAN DUTT: *Chemical examination of the fixed oil derived from the seeds of* Lallemantia royleana *Benth. or* Tukhm-i-malanga. N. ANANTHANARAYANAN: *Spectroscopic examination of the diffraction of light by a thin metallic half-plane.*

SECTION B.—S. B. KAUSIK: *Structure and development of the staminate flower and the male gametophyte of* Enalus acoroides (*L.fil.*), *Steud.* G. N. RANGASWAMI AYYANGAR AND B. W. X. PONNAIYA: *Studies on* Para-Sorghum *Snowden—the group with bearded nodes.* S. RAMANUJAM: *A haploid plant in* Toria (Brassica campestris *L.*). T. S. RAGHAVAN AND A. R. SRINIVASAN: *Cytogenetical studies in Nicotiana. Part II. Morphological features of* Nicotiana glutinosa *and the Hybrid between* Nicotiana glutinosa *and* N. tabacum. JAI CHAND LUTHRA AND INDER SINGH CHIMA: *Some studies on the potentiality of shrivelled wheat grains.* I. FROILANO DE MELLO: *First record of an Amœba parasite of an Indian Termite.*

Indian Chemical Society: (*Journal*)

April 1941.—J. C. GHOSH, S. K. BHATTACHARYYA, M. M. DUTT AND M. J. RAO: *Iodination. Part I. Studies on the equilibrium in systems of iodine and various unsaturated organic compounds in the dark in different non-polar solvents.* DUSHYANT NARASINGASA SOLANKI AND BHASKAR GOVIND JOSHI: *Electrodeposition of cadmium on Iron.* P. V. KRISNAMURTHY AND K. V. GIRI: *Studies in Vitamin-C oxidation. Part II. Influence of various substances occurring in plant and animal tissues on the catalytic oxidation of Vitamin-C.* NRIPENDRA NATH CHATTERJEE AND AMALENDU BOSE: *A new synthesis of eudalene.* P. V. KRISHNAMURTHY: *Studies in Vitamin-C oxidation. Part III. The retardation of Vitamin-C oxidation by oxalic acid.* K. N. GAIND, R. P. SEHGAL AND J. N. RAY: *Sulphonamides. Part II.* K. N. GAIND, (MISS) S. KAPOOR AND J. N. RAY: *New method of synthesis of* isoQuinoline *derivatives.* PRIYADARANJAN RAY AND BHUPESH CHANDRA PURAKAYASTHA: *Complex compounds of biguanide with bivalent metals. Part III. Nickel biguanidines.* RAMACHANDRA SAHASRABUDHEY AND HANS KARALL: *The phenylthiocarbamides. A contribution to the study of the triad-N.C.S. Part X. Action of hydrolytic agents, alkaline lead acetate and nitrous acid on thiosemicarbazide.* T. V. SUBBA RAO AND G. GOPALARAO: *Decomposition of potassium nitrate in sunlight.* PHNINDRA CHANDRA DUTTA: *A new synthesis of cadalene.*

Indian Botanical Society: (*Journal*)

July 1941.—GIRIJA P. MAJUMDAR: *The sliding, gliding, symplastic or the intrusive growth of the Cambium cells and their derivatives in higher vascular plants.* SULTAN AHMAD: *Gasteromycetes of the Western Himalayas—I.* R. K. SAKSENA: *Importance of growth-promoting substances in the metabolism of* Pythium indigoferæ *Butler.* V. NARAYANASWAMI: *A new* Gymnosporia *from Bastar State, India*—Gymnosporia Bailadillana *Narayanaswami* et *Mooney spec. nov.* (*Celastraceæ-Celastreæ*). F. R. BHARUCHA AND MISS D. B. FERREIRA: *The biological spectra of the Matheran and Mahabaleshwar flora.* GHIAS-UD-DIN AHMAD: *Effect of light intensity and temperature on the growth of* Azolla filiculoides.

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SIR M. VISVESVARAYA

IT is but fitting that a Journal devoted to the cause of science should join in the country-wide celebrations that have taken place this month, of the 81st birthday of one of the most active and effective promoters of the cause of science in India, Sir Mokshagundam Visvesvaraya. His status as an engineer has long been a fact within international cognizance. But more than his acknowledged eminence in that profession, which is undoubtedly the handiwork as well as the handmaid of science, is the urge of the modern progressivist philosophy that has permeated his outlook and activity for half a century and made him a pioneer and an exemplar to administrators and leaders of the public. His extensive travels in Europe and America as well as in Japan enabled him to acquire a first-hand knowledge of the miracles which modern science, and particularly science in the field of engineering, has wrought in the life of man, helping him to raise two ears of corn where only one grew before, to reduce his burden of brute labour, to increase the means of material welfare for all and to bring to every one more leisure, more health and more zest for the pursuit of those cultural and spiritual ideals which make human life a thing worth while. This inspiration was noticeably at work in Sir M. Visvesvaraya over thirty years ago. A high officer of the Bombay Department of Public Works at that time, he had become aware of the noble scientific-industrial idealism of Jamshedji Nusservanji Tata and the project of an all-India institution for scientific research in which that idealism was seeking to express itself; and as a patriotic son of Mysore, Sir Mokshagundam was naturally anxious that his natal State should take a hand in giving concrete shape to that project. Sir M. Visvesvaraya's voice was among the most potent of the influences which worked for the founding of the Indian

Institute of Science in Bangalore. Later on, as the Dewan of Mysore (10th November 1912 to 9th December 1918) it was given to him to give a magnificent impetus to the study and utilization of science in the service of the State. He belongs to that gifted and truly distinguished type of administrator—not too common in any country and very rare indeed in ours—who comes to office borne by the sense of an exalted mission and with a definite programme already waiting in his pocket to be taken out and put into action the moment opportunity arrives. In point of fact, the Mysore Economic Conference, which was a remarkable creation of Sir M. Visvesvaraya's dreams for the country's regeneration through the application of science to agriculture and industry and trade, had been brought into being, mainly as a result of his insistent pleading, when he was the Chief Engineer of the State and had not yet been called to the office of Dewan. The many speeches and statements he made to that organization, and the work of its numerous committees and officers under his guidance, made an impressive contribution to the general awakening of the public as also to the preparing of several important schemes of business enterprise and industrial development. The Krishnaraja Sagara, the Bhadravati Iron Works, the Sandal Oil Factory, the Soap Factory, the Silk Filatures and the University of Mysore,—to mention just a few at random out of a score or more items,—are a standing testimony to the faith of this great man in the beneficent possibilities of science as applied to the problems of human existence. It needed no ordinary amount of courage and firmness on his part to take up the responsibility of setting afoot in those days so many projects involving financial outlay on a scale to which the State had not been accustomed and affecting interests which mere prudence would rather have left unprovoked.

After his retirement from Mysore, he has kept himself incessantly at work to secure the adoption of the help of science to the solution of India's vast economic and social problems. Even a bare enumeration* of his more important reports, pamphlets and speeches will, we have no doubt, suffice to convey an idea of the volume and significance of the work done by Sir M. Visvesvaraya for translating into practical form his deep and unwavering faith in the regenerative and humanitarian office of science. Now at eighty, we find him busy promoting the scheme of an automobile factory, which has been a pet child of his

* 1 "Reconstructing India" (1919).
2 "Technical and Industrial Education in the Bombay Presidency" (1923).
3 "Presidential Address to the 10th Session of the Indian Science Congress, Lucknow" (1923).

for some years, and persuading the Indian Institute of Science, as Chairman of its Court, to adopt a plan of larger and better organised scientific research.

The pages of this Journal are not the place for an examination of the reasons for the comparative unsuccess of some of the causes espoused by Sir M. Visvesvaraya. Such an examination must necessarily take us to fields far beyond the limits we have set to ourselves. But we may just indicate what his own explanation is likely to be. Speaking at a public meeting in Poona in October 1931, Sir M. Visvesvaraya said:—

> "In 1919, in the course of my travels in Japan and the United States of America, I discussed the sterling exchange position in India with recognised financial experts whom I met. The Governor of the Bank of Japan said that the gold standard was the best for this country and he, for one, had no misgivings on the point.
>
> "I pursued my investigation in the United States of America, and it will interest you if I recall a striking incident connected with a visit I paid to a financier and banking expert of repute, Mr. Jacobson by name, who was associated with the Federal Reserve Board at Washington. I went to him with a letter of introduction and had a companion with me who was a New Yorker and a Freemason. I asked the expert what he thought of the sterling exchange position in India and what, in his view, was the best way of placing the currency policy of this country on a sound basis and preventing the losses to which it was being subjected from time to time. He was evidently unwilling, possibly on account of his official position, to speak out his mind, and began to say that India was a distant country, he had not seen it and knew little of its real position and wants. I showed some impatience at this answer, remarking that an expert of his standing could not possibly be so ignorant as he professed himself to be. He thereupon beckoned to my companion into an adjoining room and said: 'Tell this man to go back to his country, change the system of government there and come to me again for advice. I will then be able to help him'. He meant, of course, that the sterling exchange was an adjunct of a *Dependency form of government* and that no advice of his would avail unless the people in India had the power to implement their own policies. The issue of one currency ordinance on 21st September last (1931) and of another three days later to repeal the same has brought home to us, as nothing else could have done, the disabilities under which we labour by being under a Dependency form of government."

Sir M. Visvesvaraya is a man of great courage and strength of will, and never shrinks from the duty of speaking the needed word of truth and justice, whatever the reception it is likely to have from men in power or mere men. The true spirit of science characterises his views on all social questions. Friends of backward and depressed classes in Mysore thankfully acknowledge the help and encouragement he gave to the cause they hold as their own.

A most remarkable trait of his, rather disconcerting to the curious, is his complete avoidance of autobiography. He is not of the sort that wears the heart upon the sleeve. What can be seen of him by us is the man absorbed every moment of his waking hours

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4 "Presidential Address to the Indian Economic Conference, Bombay" (1924).
5 "Indian Economic Enquiry Committee Report" (1925).
6 "Vission of a Prosperous Mysore" (1927).
7 "All-India Swadeshi Exhibition Inaugural Address, Madras" (1931).
8 "Convocation Address to the Andhra University" (1931).
9 "Unemployment in India" (1932).
10 "Rural Reconstruction in India" (1935).
11 "Planned Economy for India—Popular Edition" (1936).
12 "Industrializing India" (1937).
13 "Nation Building" (1937).
14 "District Development Scheme" (1940).

in thinking and feeling and working for the public. Of the personal side of his life and experience, of his trials and struggles and disappointments with men, we get no revelation. He is a generous friend and a delightful host. A convinced supporter of clubs and corporations as nurseries of personal friendships and social felicities and disseminators of new enlightenment and new social and economic programmes, he yet has the art of keeping his soul untouched, "like a star", and "dwelling apart".

Alert in body as in mind, charming in manner, with a lively sparkle in the eyes and a friendly smile always playing round the lips, keenly interested in the affairs of the world, with faith still undiminished in the value of human striving, quick in understanding and stimulating in talk, this veteran patriot embodies in himself the generous dreams and manful aspirations of modern India. Flawless in dress, punctual in keeping engagements, a stickler for method and system in all things, uncompromising in matters of principle, but scrupulously particular not to say or do a thing likely to harm a reputation or wound a susceptibility, he is the very soul of honour and gentlemanliness. It is impossible for any one who has spent a few minutes with him not to come away infected by his enthusiasm for what he considers to be the three basic needs of India—Education, Science and Industry. He who preaches such a gospel and promotes it in all ways open to him is surely entitled to the gratitude of the scientist; and we sincerely tender our cordial and respectful felicitations to Sir M. Visvesvaraya and wish him many many years of strength and happiness for the continued service of science, and through it, of India and humanity.

—(*Contributed*)

PALÆOBOTANY IN INDIA

WE have recently received a copy of the Second Annual Report for the year 1940 on the progress of palæobotanical research in India published in Lucknow under the editorship of Prof. Birbal Sahni, and a perusal of its contents reveals the increasingly large volume of work being done in different parts of India in the field of palæobotany. As one would expect, most of this work is carried out in Lucknow, where an enthusiastic band of workers under the inspiring leadership of Prof. Sahni have been making most valuable contributions to our knowledge of Indian fossil floras. Of these special mention may be made of the paper by Mrs. Jacob (formerly Miss C. Virkki) on the "Spores from the Lower Gondwanas of India and Australia" which is a comprehensive work throwing light not only on the climatic relations of the early Glossopteris flora, but also on the possible use of these spores in Gondwana stratigraphy. Among the other subjects investigated in Lucknow may be noted (*i*) the Triassic flora from the Salt Range, and the Jurassic plants from Afghan-Turkistan by Mr. R. V. Sitholey, (*ii*) the Rajamahal flora by Dr. K. Jacob and Dr. A. R. Rao, (*iii*) the flora of the Deccan inter-trappean series in the Nagpur-Chhindwara area by Professor Sahni and Dr. H. S. Rao, and (*iv*) the fossil plants from the upper Karewas (Pleistocene) of Kashmir, by Mr. G. S. Puri.

The study of fossil algæ from the Cretaceous and Eocene rocks of India is being pursued in Bangalore where Messrs. S. R. Narayana Rao and K. Sripada Rao have been making important contributions to our knowledge of the algal flora in these beds from Rajahmundry, N.-W. Frontier Province, Sind and Surat.

Annual reports of the kind now under review are sure to be of great value in directing and stimulating further research.

A HYPOTHESIS AS TO THE ORIGIN OF COSMIC RAYS AND THE EXPERIMENTAL TESTING OF IT IN INDIA AND ELSEWHERE

BY

R. A. MILLIKAN, H. V. NEHER AND W. H. PICKERING

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THE hypothesis here adopted as to the mode of origin of the cosmic rays makes possible the prediction of five definite vertically-incoming cosmic-ray bands. As the observer moves north from the magnetic equator each of these five bands should begin to reach the earth at a particular latitude and continue reaching it at all more northerly latitudes. Between each latitude of first entrance of a band of particular energy and the latitude of first entrance of the band of next lower energy there should be found a plateau of constant vertically-incoming cosmic ray energy. Four such plateaus should be experimentally observable.

The hypothesis rendering possible these predictions rests upon five major discoveries made by the workers in the Norman Bridge Laboratory of Physics at the California Institute of Technology at Pasadena. These discoveries are: (1) that more than 60 per cent. of all incoming cosmic ray energy is of the nature of incoming charged-particle bullets (either electronic or protonic), each of energy between 2 billion electron-volts and 15 billion electron-volts; (2) Neddermeyer and Anderson's discovery of the production by nuclear impacts within the atmosphere of mesotrons which serve as the chief carriers of the cosmic ray energy down to the lower levels of the atmosphere; (3) Bowen's remarkable discovery that atoms, when out in interstellar space are able to undergo atomic transformations forbidden to them within the stars, and (4) Bowen and Wise's discovery that in ring-nebulæ, trillions of miles away from the exciting star, and therefore presumably reflecting conditions in interstellar space, there are five of the atoms, namely, helium, carbon, nitrogen, oxygen and silicon, each of which is more than ten times more abundant than any other atom save hydrogen (which must be excluded from measurable cosmic ray effects because of the smallness of its rest-mass energy); and (5) Lauritzen and Fowler's discovery in the Kellogg Radiation Laboratory that a part at least of the rest-mass energy of an atom has the power under suitable conditions of transforming itself directly into the creation of a positive-negative charged-particle pair.

The hypothesis made in view of these five discoveries is that, while the evolution of energy by the stars is maintained, as Bethe has recently shown, by the *partial* transformation within the stars of the rest-mass energy of hydrogen into radiant energy through the building of helium, carbon and other atoms out of hydrogen, and the release through this process of the so-called "packing-fraction" energy, the energy of cosmic rays on the other hand is maintained, by the occasional *complete* transformation in interstellar space of the rest-mass energy of the atoms of helium, carbon, nitrogen, oxygen, and silicon (and even heavier aggregates), into cosmic rays, each such event presumably creating either an electron pair or a proton pair (these two events are indistinguishable by our

geographic experiments), though an occasional proton pair, or neutron pair, need not *necessarily* be excluded.

The foregoing hypothesis requires that the cosmic rays of measurable energy reveal a spectral distribution of five distinct, definitely measurable bands as follows: (1) a band of rays each having an energy of 1·9 billion electron-volts produced by the annihilation, or complete transformation, in interstellar space, of the rest-mass energy of the helium atom; (2) a carbon-atom-annihilation band of energy 5·6 billion electron-volts (b.e.v.); (3) a nitrogen atom band of energy 6·6 b.e.v.; (4) an oxygen atom band of energy 7·5 b.e.v.; and (5) a silicon atom band of energy 13·2 b.e.v.

The hypothesis requires further that there should be in India, for vertically incoming rays, between the magnetic equator and magnetic latitude about 20 degrees N. a plateau of unchanging cosmic ray intensity with latitude; it requires another such plateau between the latitudes of entrance of the bands due to the silicon and oxygen atoms; it requires a third such plateau between the great band produced by the annihilation of the carbon, nitrogen and oxygen atoms, and that due to the annihilation of helium; and finally it requires a fourth such plateau north of Bismarck, North Dakota, where as the observer goes northward, the helium band should first be able to get vertically through the blocking effect of the earth's magnetic field and should then be able to enter the earth in full strength at all more northerly latitudes.

The experimental evidence that has been so far obtained in India and elsewhere for the existence of these five bands and four plateaus may be thus summarised. The India evidence seems to be good for the existence of the plateau of constant cosmic ray intensity from the equator up to Agra (17° N.) and for the appearance just north of Agra of a band that can be identified with that due to silicon. There is some evidence for the existence of the flat plateau just north of the latitude of first entrance of the hypothetical silicon band. There is unambiguous evidence for the entrance at about the computed latitude of a very strong band at between 5·5 and 7·5 b.e.v., and this we tentatively identify with the joint carbon, nitrogen, oxygen bands which, however, we have not yet been able to resolve. There is a little evidence for the existence of a plateau of constant cosmic ray intensity between the latitudes at which the carbon and the helium bands should appear, and there is fair evidence, too, for the existence of a flat plateau north of the latitude of entrance of the hypothetical helium band, the real existence of which may be stated to have been rendered probable. Not only are all the predicted latitudes in reasonable agreement with the observations, but also the observed intensities are of the right order of magnitude.

Further experiments are being made to see whether better designed apparatus will render the nature of the evidence better or worse for the hypothesis and new experiments in Mexico and the United States are planned for the coming months.

This comparison of prediction and experiment has been made possible largely through the generous support of the investigation by the Carnegie Corporation of New York and the Carnegie Institution of Washington. The success of the work in India was made possible by the extraordinarily generous and complete co-operation of the British Indian Meteorological Service.

ON THE ORIGIN AND DEVELOPMENT OF SILVER COINAGE IN INDIA*

BY

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ON July 22, 1941, I received from the Director-General of Archæology in India the eleven (actually 12) silver pieces illustrated and described here. The question that I was expected to answer was whether these were the predecessors of the later punch-marked silver coins. One glance at the weights showed that, taken as a group, they could not possibly be such predecessors, except in so far as any historically earlier bit of precious metal precedes any later one. But I was particularly intrigued by the cuneiform marks on No. 9, and asked Rao Bahadur K. N. Dikshit whether he or any of his experts had noticed anything special about that piece. In answer, he sent me a copy of his report made on the very date of his discovery, whereof the relevant portion is appended here: "1st January, 1926:—The most important discovery during this year's excavations was made on the morning of the New Year's Day when underneath a wall running east and west in the trench between sites B and C was discovered a silver vase (No. Dk. 1341) complete with lid containing jewellery, square and circular silver pieces. One of these is inscribed in cuneiform characters, thus connecting once for all, the period of the last city on this site roughly with the cuneiform world. As it is well known, the Babylonians had no regular coins but used lumps of silver and gold of definite standards known as Mana or Shekele. In the 8th Mandala of Rig Veda, Indra is asked to bring Manas of gold (Hiranyaya Mana) which conclusively proves the use of these forms of weight in India at the time when the Aryans came. The find of these rectangular and round silver pieces (the precursors of punch-marked coins of later times) with cuneiform signs is therefore of the highest importance for settling the chronology of Indian history."

My own comment on these views will appear later on. But I cannot refrain from expressing surprise and regret that this report was not made public by the authorities to whom it was submitted. The annual report for 1925–26,[1] rewritten by Mr. Ernest Mackay, states, "The find is so important that it deserves to be described in detail"[1] (89), but omits all mention of the cuneiform punches on No. 9; the vase itself is shown on Plate XLIIIc, and the contents on Plate XLII, with the piece in question shown at the bottom, though the cuneiform marks cannot be discerned clearly (due presumably to the angle of incidence of the light). No mention whatsoever has been made of the piece or of the marks on it in the imposing tomes of Marshall[2] and Mackay[3] on the subject, which is curious in view of the fact that Mackay was specially brought in as "an archæologist from outside with a first-hand knowledge of prehistoric excavations in Sumer and Western Asia"[2] (13).

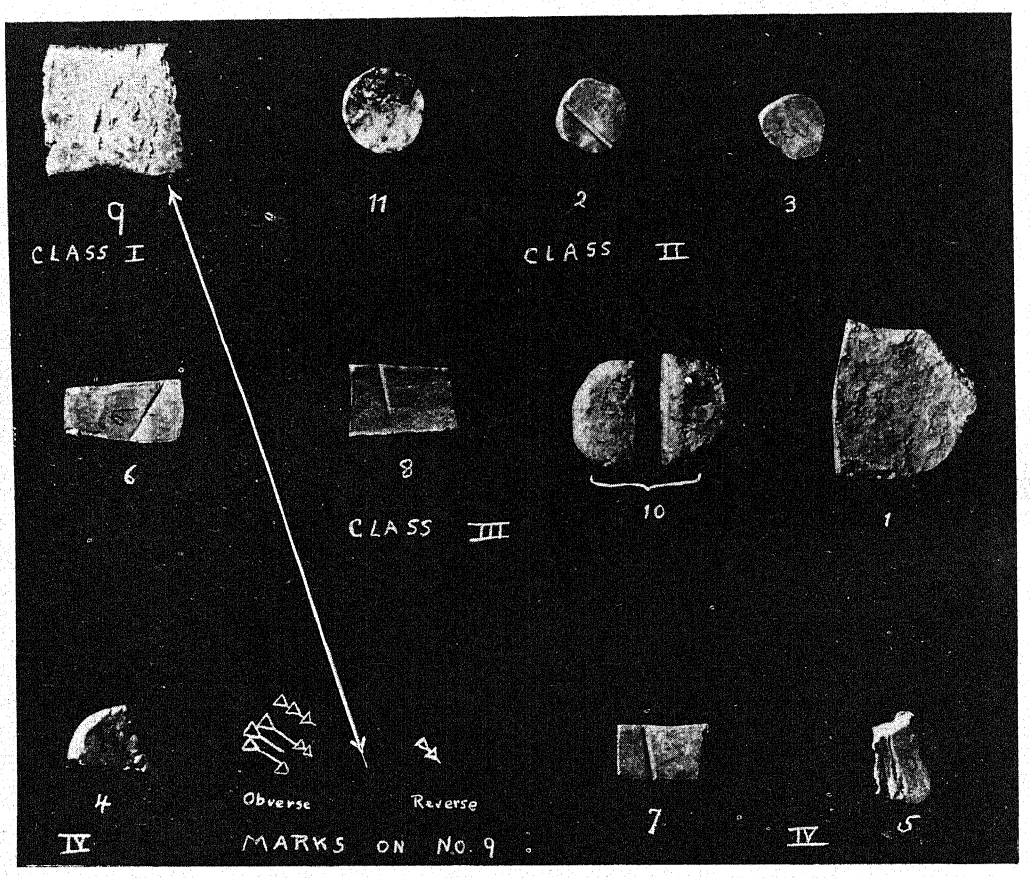
The pieces sent to me fall into no less than four classes, best described separately. With the exception of the cuneiform, on No. 9, the rest only bear "incisions", which are merely chisel marks. Such of the pieces as have been cut off from larger bits are undoubtedly cut by the process of hammering on a cold chisel and then breaking off at the mark by force; the resulting fracture shows an edge that is partly smooth and partly rough. Thus the "incisions" are trial marks, perhaps marks of the end of the chisel when making other cuts.

CLASS I. No. 9 (23·4010 gm.)—The piece has been cut off at both ends by chiselling and breaking off from a larger cast silver ingot. The process of cutting described above characterizes currency in the earliest times, and still survives in some

* The views expressed in this note are entirely my own and should not be taken as implicating or representing in any way the Archæological Survey of India or any of its officials. The weights of the pieces given here are as from my own observations, which differ little from the weights as taken at the Central Asian Antiquities Museum, Delhi, with one exception where the error is as much as one gram. The pieces are all "under field register No. Dk. 1341, except No. 10 which bears No. Dk. 6129, and No. 11 which bears No. 11337".

parts of the world. In parts of Burma, at least till 1897, it was the custom to take along a metal ingot when out shopping, and cut off suitable pieces to approximate weight as small change.[14] The pieces then continued to have their own independent existence.

followed the course of all coinage in debasement and lightening. The *shekel* of Josephus is about 210 grains, which is almost exactly the Mohenjo-Daro weight that amounts to four times the *kārṣāpaṇa* weight of our punch-marked coins. But this is probably insignificant, because the



Silver Pieces found at Mohenjo-Daro in 1926

Assyrian inscriptions mention "sealed" *minas* and *shekels* from the time of Sennacherib onwards, and these are taken by archæologists to be cast roundels, which might have resembled our Class II here. Our piece seems to be too light to be a *mina*, and is too heavy for any *shekel* within my knowledge. It is to be noted that the standards of weight varied; an accurate study, particularly of hoard material, might enable us to date the piece according to its weight-standard. The Assyrian *zuzu* continued to be known in early Christian times as a round coin of very small value, having earlier *shekel* (= 1/3000 talent) whether Attic or Hebrew, was heavier.

The inscription on the reverse is most probably to be read as *gam* or *gur* ([4] No. 206; [5] No. 318; [6] No. 344) taken horizontally, with less probability, it would be sign No. 2, *ḫal*. The meaning is not clear when the sign stands by itself, but here it might indicate "to pour forth", perhaps the casting of the original ingot. The larger ideogram on the obverse would certainly have been taken as a mark of denomination or a numeral sign, but for the fact that three of the wedges are long. Even now it

is difficult to see what else it could indicate in view of the fact that all the wedges point in the same direction without a single cross or *u* wedge. The nearest signs to it are the *in* of Elamite inscriptions at Behistūn, and *dugud* [Barton[5] (401)]; it is certainly neither of these. I hope expert Assyriologists will forgive my amateur efforts, as also the fact that I am unable to see anything special in the signs that might permit us to date the find. The "cuneiform world" endured from at least 2500 B.C. to the Persian Empire; and we know that Alexander's conquest and the supersession of the Empire by the Seleucids did not end the use of cuneiform, inasmuch as an inscription of Antiochus Soter (280 B.C.) has been found in quite good Assyrian. Not only that, the "letters of the Ammunneer" of Philo Byblius probably refer to the Ras Shamra alphabet and would indicate that there existed people who could read cuneiform writing in very much later times, though the full bloom of the Assyrian language begins about 1400 B.C.

The primary importance of the piece, then, derives from the obvious conclusion that it was imported from the West, presumably Mesopotamia, in the way of trade. Silver deposits are not known in India within reach of the Indus Valley; it would seem likely in view of the Indus seals found in Mesopotamia that all the Indus silver was imported thence in payment for other commodities. The piece under discussion and other pieces of the find show us that we are, before the last city on the Mohenjo-Daro site, already at the beginning of a rough coinage system. A late Sanskrit word for such a cut and broken piece of silver or gold might be *kanakabhaṅgaḥ*, which is found in our lexica. But, along with the silver, the coinage system is also imported so far, because the pieces, *except Class IV*, do not conform to the general standard of weights found at Mohenjo-Daro and Harappa.

In some respects it might be possible to go further than this. There are many who assert that an intimate connection between Sanskrit and the cuneiform script must have existed, because Sanskrit is yet a "syllabic" language, our alphabets still bearing the consequent marks of intricacy; as with the cuneiform ideograms, a single Sanskrit word can mean a large number of ideologically unconnected things. Some have attempted to trace Assyrian roots and names in the Vedas, attempts originating in as well as hampered by the authors' lack of mastery over one or (as in my case) of both the languages concerned, and their disregard for the fact that we are at the dawn of modern language structure, in an age when language itself was one of mankind's rare instruments. It would, however, be possible to admit that in the very first line of the Rigveda the root *il* occurs which can be connected with the Assyrian *ilu* = god. And the cuneiform determinative *ilu* can also be read as *an*, which is the name of one of our ancient deities. But all this need not be relevant here because the root can also be taken as Dravidian, and even to-day the Brahui language is a Dravidian survival far to the north, surrounded entirely by Aryan languages. The Aryans who succeeded, perhaps ruined, the Mohenjo-Daro culture could have had their contact directly with the Assyrians in Asia Minor or Mesopotamia, as witness the Mitanni inscriptions, and the Asuras mentioned so often in the Vedas. By this, the Asura Vipracitti would be a Hittite, as citti(m) = hittim (Hebrew) seems to be a permissible equation. The Assyrian word for silver ka-as-pu might have left the Sanskrit root *kās* or *kaṣ*, to shine.

As I have said, there is no evidence that these speculations are to the point when dealing with Mohenjo-Daro.* The question might be raised, however, whether the cuneiform marks could not have been made in India. Certainly, there has been found one seal, at Ur itself, which is definitely of the Indus type but bears cuneiform marks in place of the usual linear Indus script[2] (406, 413). The evidence before us at most allows us to expect that there were some people in the Indus basin, whether indigenous or immigrants, who might know how to use cuneiform, but it could never have been a common script in India. The Sanskrit for a cuneiform seal, punch, or ideogram would be *kīlamudrā*, which is not to be found in the dictionaries, though it might conceivably occur in some obscure tantric work; Lüders,[7] however, has pointed out that the Prakrit equivalent does occur in the Niya Kharoṣṭhī

* The war has made it impossible to communicate with the leading Assyriologists. It would have been most helpful, for example, to be able to consult Hrozný's reported decipherment of proto-Hittite inscriptions on Indus seals.[8]

tablets, where he takes it to indicate the sealed wedge-shaped documents themselves. Two Assyrian clay tablets of about the sixth century B.C. relating to the sale of two women were found in a Bombay store-room;[8] the provenance being unknown, these are probably to be taken as modern imports from some tourist's acquisition at a Mesopotamian site. Pran Nath[9] reads a wedge as *ni* on a punch-marked coin in the Thorburn collection, but this too seems doubtful to me. The one find comparable to that described here is the pot-inscription published by C. L. Fábri[10] as a Sumero-Babylonian pre-cuneiform label. But even here, the reading was contested by Heras[11] who preferred to read the complementary area on the pot itself as being typical Indus writing. So, we have before us the first, and at present the only, known cuneiform and definitely Mesopotamian writing in ancient India.

CLASS *II*.—This consists of three round pieces which have really nothing in common but their shape; they form no system of weight, and as each is manufactured by a different process, it is doubtful whether they represent coinage. There is just a chance that they were meant to find their way into a jewellery pattern, which need not, however, conflict with their interim use as coins No. 3 (2·2177 gm.) has been flattened out from a cold silver pellet or other smaller piece by means of hammer blows of considerable force, as is seen from the cracks that have developed at the edges, and the appearance of the surface. No. 11 (2·9353 gm.) is of very bright silver, but has a patch of brown lacquer-like coating that prevents a thorough examination. From its shape and general appearance, it must have been cast to size and then lightly worked over. No. 2 (4·3108 gm.) has been trimmed from a larger silver plate, the corners being neatly rounded off. The only mark it bears is the common chisel-mark or incision.

CLASS III.—This can be taken, roughly, to form a system, though the system cannot be associated clearly with any known Indus weights. The basis might, at best, be connected with the Paila coins, about which I have not at present sufficient information for a definite statement; if the coins now in the Lucknow Museum become available for study at some later date, the point could be settled. The nearest pieces in this group are too heavy for the Taxilan "long-bar" coins. It must be kept in mind that the standard is only roughly followed; but it would seem to be a foreign standard so far as can be judged from the evidence. No. 6 (2·8867 gm.) is cut and broken off from a thin plate, rather like the later punch-marked coins in appearance, but too light for the kārṣāpaṇa. The sole mark is a chisel mark on the face. No. 8 (5·8353 gm.) is similarly manufactured, but with only one rough edge, one chisel mark on face. No. 10 actually happens to be two pieces made by cutting a round, fairly neat, well-filed piece almost exactly in two with a blunt cold-chisel. It is described as "broken", on the DGA's containing envelope. This might denote completion of the fracture after excavation, but the original intention of cutting the piece in two is in any case obvious. It is also clear that whoever did the cutting had had plenty of practice, inasmuch as the two pieces weigh 5·9039, 6·0720 gm.; an excellent dichotomy, considering the bluntness of the tool. Finally, No. 1 (19·4787 gm.) is apparently half of a still bigger piece, the cut edge having been made smooth. The system of weights is apparently on the scale of 1, 2, 2 + 2, the last being close to seven units, which does not coincide with the dual Indus system of increasing weights. Perhaps, the last piece should not be included here at all.

CLASS IV.—These three pieces are weighed on the Indus system, and if there be any "precursors" of the punch-marked coins in the pieces sent to me, they can only be these. These are all from one find (Dk. 1341), seem unfitted for use as jewelry without further shaping, and the weights belong approximately to the Indus Class D, being: No. 4 = 3·3576 gm., No. 7 = 3·7025 gm., No. 5 = 3·9282 gm. The first is a sector from a round piece, the second from a plate cut off after several trial attempts; the third also trimmed from a plate, but with one edge probably circular in the source. The fact that claims our attention here is that these are significantly cruder (by the z test) than the Mohenjo-Daro Class D weights or earlier Taxilan kārṣāpāṇas; and also significantly heavier than both by the t test. There are two interpretations possible: that the pieces represent purchases of silver to an approximate Class D weight; or that they were to be smoothed down at a later date to the precise weight, having had a little

margin left and in fact as little margin as possible with fairly clumsy cutting tools. If the latter explanation is accepted, the conclusion must also be taken that we are already beginning to see bits of a precious metal trimmed to a standard weight, hence the beginning of a coinage system. In any case, the coinage that came later must have originated in some such way, if this be not its immediate origin.

The later developments are quite clear. Even after the destruction of Mohenjo-Daro, which is entirely a trade city as shown by its fine weights and poor weapons, the traders persisted, and continued to use the very accurate weights of that period. The first marks were traders' marks, such as are seen on Persian sigloi, and the reverse of the punch-marked coins of the pre-Mauryan age. This is shown clearly by one coin published by the late Babu Durgā Prasād.[12] This coin is blank on one side like our Mohenjo-Daro pieces, but the other contains no less than thirteen small marks, similar in type to those known as the later "reverse" marks. For the earlier Taxila hoard I have established these marks[13] as having been regularly placed in time, with a loss of about 0·2 grain weight per mark. Moreover, the newest coinage of the earlier Taxila hoard, B.E.2, shows that if a single standard prevailed for those coins, it must have been almost exactly 54 grains at the time of issue. So, Durgā Prasād's coin, weighing (according to him; I have not been able to check the weight) 105·75 grains would have been worn down from the 108 grains double-kārṣāpāṇa, particularly as the central one of the 13 marks seems to me to be an issue mark.

My contention is that the manufacture of coins continued to be the traders' function for a long time after the Indus period; that the small marks were put on according to a system generally understood at the time by those who handled the coins most frequently. It follows from my previous work that the traders (or the Vaiśya caste) were very accurate in their workmanship, and gave good value.

At a *later* period but not later than the sixth century B.C., the Kṣatriya steps in as the king who claims the royal prerogative of stamping his own marks on the coins. The punch-marked coins then begin to have larger obverse marks, usually five in number (four for the Paila coins), and are issued with a blank reverse. The Mohenjo-Daro accuracy still persists, the trader still continues to stamp on his own small reverse marks as per his own checking system, till the Mauryan period. This ushers in coins characterized by the crescent-on-arches mark on the obverse, and the system of traders' reverse marks disappears very soon, being replaced by a single large reverse mark, such as the "Taxila mark", or some other characteristically Mauryan stamp. The superb accuracy of the weighing is also lost, and the coins have much more copper than before. Some of my critics wonder at this cruder technique, which seems unlikely to them in view of the *Arthaśāstra* and the fine sculpture, architecture, epigraphy of the Mauryan era. I prefer to form my judgment from the coins themselves. As a matter of fact, the present year in India is certainly not inferior in productive technique to any of its predecessors; but, due to pressure of increased trade and a corresponding increase of the need for coinage, along with a certain amount of hoarding caused by the war, the new rupees will be found inferior in minting to the older ones. At least, they contain more copper (an increase from $^1/_{12}$ to ½), and the varience at the time of minting[15] is, to the best of my knowledge, much greater for the George VI than for Victoria, Edward VII, or George V rupees. The parallel explanation is undoubtedly that the Mauryan conquests opened up entirely new regions; the old, limited, slow, cumbrous trading system between India and Mesopotamia must have vanished against the pressure of a rapidly increasing volume of trade in the new areas opened up in the south. At any rate, the primitive tumuli, the pāṇḍukuḷīs, of the southern part of the peninsula survived so late as to contain coins of Augustus, not to speak of our punch-marked coins. Not only that, in such southern hoards as I have been able to study, the proportion of Mauryan coins is very large[16] some hoards of over a thousand coins apparently consisting entirely of punch-marked coins of the later Mauryan period or their imitations. This can mean only one thing: that coinage as such was virtually unknown in the south of India before the Mauryans. In the north, we rarely get a Mauryan hoard of any considerable size unmixed with pre-Mauryan coins. The later Taxila hoard of 168 coins is purely Mauryan (excepting one coin of Diodotos),

though so crude in fabric as to be suspected as a forgery; and all but five coins are in mint condition, which indicates some unusual circumstance attending the deposit.

Thereafter, we come to the period of cast coins, which nevertheless retain some of the earlier marks. Local and transient weight systems also develop, and the unifying influence of the trader is entirely lost, probably because of the development of large kingdoms at war with each other, each with its own provincial culture and language. Indian numismatics thereafter becomes a branch of epigraphy.

Nevertheless, in closing this note, I wish to point out the necessity of studying *hoards* of coinage as a whole and for every period if we are to reconstruct the lost economic and political history of our country from our unusually meagre and conflicting records. For example, from a study of the earlier Taxila hoard, I have been able to show that the Taxilans enjoyed comparative economic stability for at least sixteen and probably twenty indictions, say two centuries or more. But a great deal more can be said from the mere structure of the hoard. Of its 1175 coins, 1059 were exactly of the type found further east with maximum density at or near the ancient Magadhan Kingdom; 79 were minute coins, the small change of the day, and might have been local; as also the 33 "long-bar" coins, not found in Magadha, which are close to being double-sigloi. Just four more coins were found in the hoard: two of Alexander, one of Philip Arrhidaios, and an unidentifiable Daric (siglos). This shows quite clearly that Taxila belonged to the Indian, Magadhan, economic sphere at a time when it is supposed to have been a part of the Persian Empire, or at least in the Persian political sphere, since the conquests made by Darius I. The balance of trade, moreover, was in favour of Taxila, the coefficient of survival for currency being ·71 for the currency so regularly imported from the east. Therefore, after Alexander's invasion had swept away the stronger tribes of the Punjab that acted as buffer states, a Magadhan conquest of Taxila was inevitable. Therewith must have followed the doubtful status of a frontier dependency to replace what had essentially been a center of exchange between two vast trade regions, and the Taxilan economic advantage must have been lost. This would explain the revolts that are referred to as having occurred at Taxila, one of which Asoka[17]—apparently—had to quell as viceroy; and the speedy ruin of Taxila following the Mauryan conquest. But without the hoard material, we must always remain in doubt as to the true significance of our literary sources. Just as a race has to be studied by taking a fairly large sample of its representatives, so also the coins left by a vanished age must be studied by looking at their weight and chemical composition *in a group*. A single coin is just about as representative of the culture as a single individual of the race.

I am grateful for Dr. S. M. Katre's revision of the proof.

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[1] Archæological Survey of India, *Annual Report*, 1925–26, pp. 72–98.

[2] John Marshall, Editor, *Mohenjo-Daro and the Indus Civilization*, London, 1931, 3 vols.

[3] E. J. H. Mackay, *Further Excavations at Mohenjo-Daro.*

[4] J. Rosenberg, *Assyrische Sprachlehre u. Keilschriftkunde*, 2nd ed.

[5] G. A. Barton, *The Origin and Development of Babylonian Writing*, Part II, Leipzig and Baltimore, 1913.

[6] G. Howardy, *Clavis Cuneorum*, London, Leipzig, Kopenhagen, 1933.

[7] H. Lüders, *Die Śākischen Mūra*. Sitzb. Preuss. Akad. Wiss., 1919, Phil.-Hist. Klasse, pp. 734–66, particularly p. 742.

[8] Tablets at the Bhandarkar, O. R. Institute. See *JAOS*, 1920, **40**, 142–144.

[9] Pran Nath, *Indian Historical Quarterly*, 1931, **7**, Supplement, **14.**

[10] C. L. Fábri, *Indian Culture*, 1936–37, **3**, 663, 673, plate.

[11] H. Heras, *Indian Historical Quarterly*, 1937, **13**, 697–703.

[12] Durgā Prasād, *Journal of the Asiatic Society of Bengal*, 1935, Numismatic Supplement No. **45**, 13, Plate 7.

[13] D. D. Kosambi, *New Indian Antiquary*, **4**, 1941.

[14] R. C. Temple, *Indian Antiquary*, 1897, **26**, 160–162, *et al.*

[15] My own observations show that the variance of the George VI (1940) rupees is not less than that of George V rupees twenty-three years in circulation, *i.e.*, of the order of three to four times the former minting variance. The legal remedy seems to have been relaxed to more than twice its former value of 1/200.

[16] From a letter of Dr. K. N. Puri, this seems also to hold for his Rairh finds in Jaipur State.

[17] *Divyāvadāna*, (ed. Cowell and Neil), p. 371 seq.

RESEARCH WORKERS AND THE PATENT SYSTEM*

II. WHAT IS PATENTABLE?

BY

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"ORIGINALITY" may be said to be a *sine qua non* for enjoying protection under the patent system. But every achievement of human effort where originality has been displayed is not capable of being protected by means of patents. Patents are granted for 'inventions' only, and the term 'invention' may be defined as 'any manner of new manufacture'. It is obvious from this definition that patentable subject-matter should possess 'novelty' and should be essentially a 'manufacture'. It has, however, been held by the courts that anything which is a 'manufacture' and which has 'novelty' is not necessarily a 'manner of new manufacture' and that in order to fall within the scope of the latter expression the subject-matter should necessarily be the outcome of 'inventive ingenuity'.

In this article, an attempt is made to give concrete ideas underlying the expressions 'novelty', 'manufacture', and 'inventive ingenuity', as they are understood in patent law.

(i) *What is 'novelty'?*

The significance of the expression 'novelty' will now be considered. In patent law 'novelty' is not understood in its strict etymological sense, and does not imply the state of being never known before. The patent laws of various countries have laid down different standards of novelty requisite for the grant of patents within their jurisdiction. The scope of this article, however, will be confined to the requirements of the British Patent System, on which the patent laws of this country are based.

The 'novelty' of an invention is invariably considered with reference to what constitutes 'public knowledge within the realm'. It has therefore to be judged from the territorial as well as the "public knowledge" aspects.

The origin of the territorial aspect of 'novelty' may be traced to the early days of the patent system, when artificers from abroad were encouraged to settle down in England and introduce new manufacture within the realm, by the grant to them of monopolies in respect of such manufactures. Due to this territorial aspect of 'novelty', it is now possible to obtain patents for inventions which, though already in existence abroad, are new within the realm.

The real significance of the 'public knowledge' aspect seems to have been not fully appreciated by those engaged in research, as, in many cases, inventors have failed to enjoy patent protection on account of their utter disregard of the principles underlying it. The subject therefore deserves more than a passing reference, and will be dealt with at some length in this article.

Now, one of the cardinal principles of the modern patent system is that under no circumstances must a patent interfere with the rights of an individual to make use of any manufacturing processes or apparatus which has come to his knowledge, unless the right to the exclusive use of such process or apparatus has been previously reserved by someone else. In the ordinary course, he may obtain this knowledge by seeing the process or apparatus actually at work in a factory or in a show-room, or at a demonstration or at an exhibition; or he may obtain it by reading a description of the process or apparatus in a publication, or by hearing an account thereof by way of lectures. The information which is thus made available to the public before it is

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* The views contained in this article reflect the views of the author only and do not represent those of the Government of India and should not be taken as committing the Government of India in any way.

protected by applying for a patent for it, is taken as being unconditionally dedicated for general public use, and as such, cannot thereafter be monopolised by anyone, including the author of the information. This principle, however, is completely disregarded by many scientific workers in various ways, some of which are briefly referred to in the succeeding paragraphs.

For example, a large class of inventors are under an impression that for establishing their prior claim to inventorship, they should publish an account of their researches in scientific journals, at the earliest possible opportunity. They seem to forget for the time being that the patent system not only provides them with an equally well recognised means of establishing their priority, but has the added advantage of retaining their proprietary rights over their inventions. By rushing to the press in the first instance, they lose once for all their proprietary rights over the invention published, because the moment an invention is published without applying for a patent for it, it becomes the property of the public. Inventors of this class should therefore remember that even if they are anxious to establish their priority of inventorship, it is advisable for them to file their patent applications at least simultaneously with the publication of their inventions in the scientific journals, if not before such publication.

These remarks apply with equal force to the publication of inventions that takes place through the reading of papers before learned societies, or through the delivering of popular lectures, or through demonstrations at exhibitions. Wherever such publication takes place before steps are taken for the protection of the inventions concerned, the said inventions become thereafter a part of the stock of public knowledge and even the inventors will not be allowed to interfere with the rights of free use of the invention by the public.

It is recognised, however, that considerable time will be taken up for making a proper application for a patent and that the exigencies of the circumstances may demand an immediate publication of the inventions made by scientific research workers. To meet such a situation, a special provision is made in the Indian Patents and Designs Act, *vide* Section 40, by which inventors are allowed to publish their inventions at exhibitions or before learned societies, even before making a proper application for a patent, provided they pay a small fee of Rs. 5 and send a brief description of their invention to the Patent Office. By adopting this simple course, inventors could proceed with early publication of their invention at exhibitions or before learned societies, without prejudicing their right for filing a proper application for a patent after such publication.

Some inventors who are in need of financial backing for the exploitation of their inventions often find it necessary to explain the working of their inventions to the potential financiers, and very often they do so without enjoining any promise of secrecy. These inventors ignore that the financiers who come into the possession of the full knowledge of such inventions in such circumstances, can, if they choose, make use of the inventions without any recompense to the original inventors. Even where such a disclosure takes place in a confidential manner, the inventors very often find it extremely difficult to establish that the disclosure was made confidentially. It is therefore best not to disclose the invention to others except after filing an application for a patent; but where this is unavoidable, inventors should take particular care to have at least some documentary evidence of the secret nature of the disclosure made to the financiers.

The same precaution should be taken where, at the experimental stage, it becomes necessary to disclose the invention to mechanics and technicians whose services may be engaged for completing the invention.

Another danger to the novelty of an invention may arise from the fact that it was developed in a workshop or a factory where other employees who are not bound to secrecy had ample opportunities to obtain a knowledge of the invention. In such cases, these other employees would be at liberty to disclose the invention to rival manufacturers or to make use of the invention for their own benefit to such an extent as to constitute a bar to the grant of the patent to the inventor. The only safeguard against this danger is either to work out the experiments secretly or to adopt a system of binding all employees to a bond of secrecy.

The foregoing paragraphs illustrate how owing to a lack of proper appreciation of the "public knowledge" aspect of "novelty", the inventors themselves destroy the novelty of their inventions. Cases in which the responsibility for the public knowledge of the invention does not fall on the inventors, are also deserving notice, because an invention which has become publicly known, whether through the inventor or through any other source, would be thereafter not "novel". In this connection, it should be noted that an important source of public knowledge of inventions in this country is the patent literature available at the Patent Office at Calcutta.

Abridgements of thousands of specifications of patents granted in the United Kingdom, U.S.A. and Australia, and also the publications of the Indian Patent Office, are available for inspection in the public room of the Patent Office, and any invention which is described in any of these documents is deemed to have lost its novelty. Applicants for patents very often argue that their inventions were made by them independently, or that what is described in the aforesaid patent literature, is not actually "in practical use" in British India, and that the mere fact that a paper anticipation of the invention was available at the Patent Office, should not be a valid ground for refusing the grant of a patent for their invention. It is therefore worthwhile to repeat here that individual inventive merit involved in an invention is not the sole criterion for the grant of a patent, but the novelty of the invention with reference to what already constitutes 'public knowledge' has an equally important bearing on the question.

It is also noticed that research workers realise only too late that the ordinary technical literature which is consulted by them in connection with their researches contains but a small fraction of the inventions disclosed to the public through the patent literature mentioned above. The importance of consulting the patent literature before undertaking elaborate investigations cannot therefore be overemphasised, as, the omission to do so might lead merely to the rediscovery of what was previously invented by others.

It is also necessary to refer here to the special case whereby even the secret use of an invention imposes a disability on the inventor as regards its patentability. This is contained in Section 38 of the Indian Patents and Designs Act which provides that an invention shall not be deemed a new invention if the inventor has not by secret or experimental user made substantial profits from his invention. Due to this provision an inventor cannot, by resorting to secrecy in the first instance, hope to enjoy a monopoly for his invention for a period over and above that which would be available to anyone who comes for a legal protection under the patent system. This serves also as an additional inducement to the inventor to apply for his patent as soon as he completes his invention, without keeping it back from the public with a view to work it in secrecy.

The practical aspects of "novelty" may therefore be summed up as follows:—

(1) before undertaking researches of practical utility, research workers should in the first instance, study the patent literature available on the subject;

(2) as far as possible, the results of researches should not be disclosed to others before taking proper steps to protect the inventor's right;

(3) if, however, it becomes absolutely necessary to disclose the inventions to contractors, capitalists or co-workers, even before applying for the patent, care should be taken to enjoin secrecy; and where possible, evidence should be created of the confidential nature of the disclosure; and

(4) if there is an idea of patenting an invention, the invention should not be worked for profit before applying for a patent therefor.

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REACTION BETWEEN ETHYL IODIDE AND COPPER SALTS

During our investigations on the catalytic effects of various salts on the kinetics of the persulphate-alkyl-iodide reaction,[1] we observed that copper salts accelerated the reaction to a great extent. This anomaly could not be explained. Now, it has been found that there is a reaction taking place between copper salts and ethyl iodide even in the absence of the persulphate, liberating free iodine and hence the abnormally high results are obtained in the persulphate-alkyl-iodide reaction catalysed by copper salts.

This action of copper salts on ethyl iodide can be compared with the action of mercuric and silver salts on alkyl halides.[2] These two ions, silver and mercuric, have a great affinity for the halide ion, which may be due to the small ionisation of the mercuric halides, to the insolubility of the silver halides, or to the fact that silver halides dissolve in excess of halide ion forming complexes of the nature of AgI_2. It may be possible that other ions which form moderately stable complex halide ions like copper may also bring about similar reactions with alkyl halides.[3] This deduction led us to investigate the action of copper salts on alkyl halides.

We have found that the progress of the reaction can be followed by the ordinary iodometric method, after extracting the iodine with benzene. Such extraction of iodine is necessary on account of the deep colour of copper salts which mask the colour of iodine, making a direct titration against standard thiosulphate solution impossible.

The reaction has been found to be kinetically of the first order, with respect to the alkyl iodide. The probable mechanism of the reaction may be a preliminary dissociation of the alkyl halide into free radicals (a unimolecular process) followed by faster reactions involving copper ions and iodine ions or radicals as in the persulphate-alkyl-iodide reaction.[4] Further details regarding this will be published later on.

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M. S. Telang.
V. V. Nadkarny.

Ramnarain Ruia College, and
St. Xavier's College,
Bombay,
May 12, 1941.

[1] Telang and Nadkarny, *J. Indian Chem. Soc.*, 1939, **16**, 536.
[2] Burke and Donnan, *J. Chem. Soc.*, 1904, **85**, 555.
[3] Hammett, *Physical Organic Chemistry*, 1940, 138.
[4] Telang and Nadkarny, *Curr. Sci.*, 1940, **9**, 226.

A SENSITIVE TEST FOR THE DETECTION OF ARGEMONE OIL

RECENT investigations, specially of R. B. Lal and co-workers, incriminating argemone oil as the factor responsible for the production of epidemic dropsy, have naturally aroused considerable interest. The present author pointed out some anomalies of this theory and also reported that a sample of mustard oil prepared in a special way from mustard seeds free from those of *Argemone mexicana* was positive to so-called physical and chemical tests for epidemiologically incriminated mustard oil. The nitric acid test which has been used so long for qualitative and quantitative purposes is far from satisfactory since it is not at all a specific test for argemone oil and is given by a large number of other substances.

It has now been possible to develop a very simple and sensitive test for argemone oil. This will enable us to detect the presence of argemone oil in mustard oil up to a concentration of 1 per cent. and can be conveniently used as a routine procedure.

The test may be carried out by heating in a water-bath 2 c.c. of the suspected oil with concentrated hydrochloric acid, ethyl alcohol and ferric chloride solution when an orange-red precipitate will be formed in the lower acid layer or may be collected at the acid-oil interface. If the conditions are favourable this precipitate may be converted into beautiful orange-red fibrous crystals.

The importance of this test lies in the fact that three proved potent (dropsy-positive) samples of mustard oil are negative to this test showing that *the samples do not contain argemone oil even in the concentration of* 1 *per cent.* There is another peculiarity of this test. In the case of the proved potent mustard oils, the oily layer turns deep black while it is faintly tinted, if at all, in the case of fresh and pure 'ghanni' mustard oil. There are indications that this test may be used to detect impure mustard oil. Full details will be presented elsewhere.

I may add that these tests have been kindly verified by Prof. S. N. Bose, F.N.I., to whom my best thanks are due.

S. N. SARKAR.

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Chemical Laboratories,
The University, Dacca,
August 25, 1941.

AN IMPROVED VOLUMETRIC METHOD FOR THE ESTIMATION OF URIC ACID

Two disadvantages of the usual titrimetric procedure,[1] for the estimation of uric acid in urine are (*a*) the tedious necessity to wash the precipitate free from chlorides and (*b*) the absence of a clear end-point with permanganate. Ceric sulphate overcomes both these defects in that (*a*) the reagent can be used in high concentrations of chloride,[2,3] thus obviating the necessity for washing the precipitate chloride-free and (*b*) an exceedingly sharp end point is obtained with *o*-phenanthroline-ferrous complex indicator.[4,5]

Theoretical values having been obtained with pure solutions, and with synthetic urines containing known amounts of uric acid, the method finally adopted for the determination is as follows:—

A suitable aliquot is pipetted into a centrifuge tube, sufficient ammonium chloride added to make the salt concentration 20%, and dissolved by gentle stirring if necessary. Strong ammonia (1 c.c. of sp. gr. 0·88 for 10 c.c. liquid) is now added, the contents thoroughly mixed, and set aside for two hours. The precipitate is then centrifuged, the supernatant liquid decanted off and the sides of the tube well drained. It is then washed with a saturated solution of ammonium chloride containing ammonia (5 c.c. of sp. gr. 0·88 for 100 c.c.), and afterwards taken up in 1 : 1 HCl (10 c.c.) treated with sulphuric acid (5 c.c. 1 : 1), and an excess of 0·02 N ceric sulphate, as indicated by a persistent light yellow colour of the mixture. The contents are diluted to about 100 c.c. making the final concentration

0·5–1·0 N in sulphuric acid, and the excess of ceric sulphate titrated with 0·01 N ferrous ammonium sulphate (connected to a microburette over alkaline pyrogallol), using o-phenanthroline indicator. Just before use this indicator is oxidised to the neutral point (purple) with ceric sulphate, and two drops of the neutralised indicator are used for each titration.[6] The uric acid content is calculated from the quantity of ceric sulphate used up, 1 c.c. of 0·02 N ceric sulphate corresponding to 1·68 mgm. uric acid.

The recovery of added uric acid in 3 samples of urine by this method were as follows:—

Uric acid content of urine	Uric acid added	Uric acid found
mg.	mg.	mg.
19·59	5·00	24·53
20·73	10·00	30·52
21·91	25·00	45·94

The stability of ceric sulphate in dilute solutions considerably enhances the usefulness of the method. With slight modifications it can also be adapted to the estimation of uric acid in avian excrement and similar biological materials rich in uric acid. Full details of these procedures will be published elsewhere.

Y. V. Narayanayya.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
June 17, 1941.

[1] *Practical Physiological Chemistry*, Cole, S. W., 1933, 9th Edn., p. 326.
[2] *J. A. C. S.*, 1928, **50**, 1322.
[3] *J. Chem. Educ.*, 1934, **11**, 466.
[4] *J. A. C. S.*, 1931, **53**, 3908.
[5] *Ibid.*, 1933, **55**, 3260.
[6] *Jour. Biol. Chem.*, 1938, **123**, 199.

TOP-ROT ('TWISTED TOP' OR 'POKKAH BONG') OF SUGARCANE, SORGHUM AND CUMBU

Top-rot or 'pokkah bong' of sugarcane is prevalent in Java, Australia, Louisiana and Hawaii (Martin, 1938)[1] and has also been recorded from India (Subramaniam, 1936).[3] During the year 1940, the same disease was noticed in South India at Kulitalai in May and at Coimbatore in December. In both the places the disease broke out after the rains. The spindle was distorted and the shortened leaves were rolled into whiplike structures. Reddish brown patches were present on the sheaths and base of blades and the tissues were torn. The end of the whip had turned brown and rotted. In extreme cases the terminal portion of the stem also rotted. The discoloured portions on incubation produced growths of *Fusarium moniliforme* Sheld.

A 'twisted top' disease of sorghum was for the first time observed in October 1939, on the Central Agricultural Station, Coimbatore. The affected plants had the upper leaves linked together forming arches. The tips of the younger leaves were rolled inside those of the older ones. This process was repeated until most of the leaves of the plant formed a series of arches one over the other on one side of the plant. The upper nodes were shortened and usually the earheads were not produced (Fig. 1). The rolled tips were brown and in moist weather a growth of fungus was seen on the surface. The disease was again noted in November-December 1940. On all these occasions it was observed only after the rainy weather. The rolled tips produced on incubation growths of *F. moniliforme*.

In July 1940, a similar disease was noticed on cumbu (*Pennisetum typhoides*) at Coimbatore. The plants were stunted and the top leaves were shortened, twisted and rolled into one another. No earhead was developed (Fig. 2). The blade of some of the leaves had dwindled down and what was left was brown and split up. The rolled portions had partly

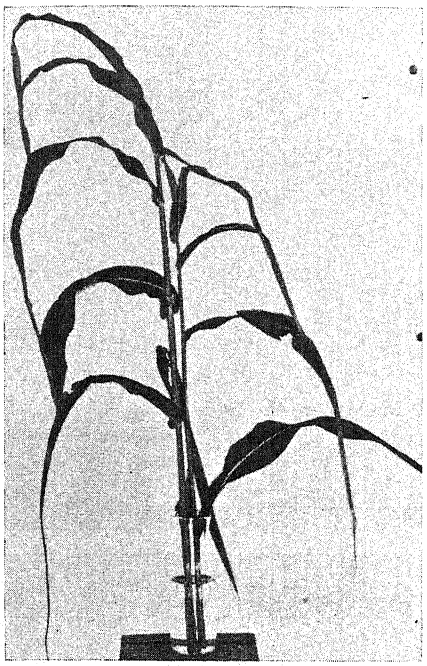


FIG. 1
Symptoms of the disease on sorghum

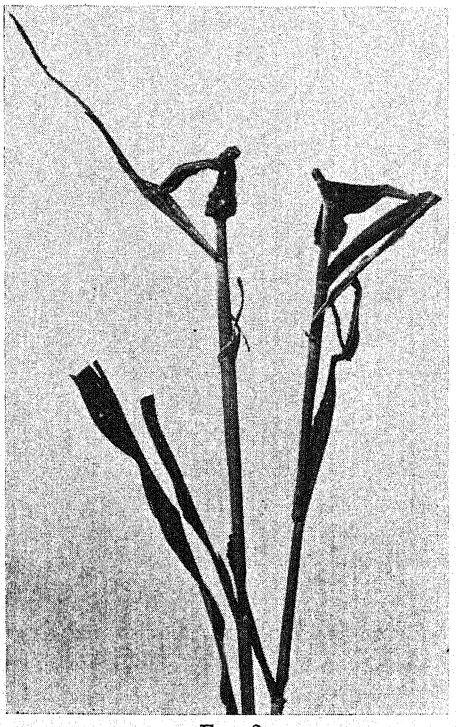


FIG. 2
Symptoms of the disease on cumbu

turned brown and rotted. *F. moniliforme* was isolated from the diseased portions.

The three isolates of *F. moniliforme* were grown on french-bean and quaker oats agars and steamed rice. On french-bean agar all the three isolates produced white mealy growths. The growths are more profuse and light cream coloured on quaker oats. The medium is coloured light purple, the depth of the colour being most with the sorghum, less with the sugarcane and least with the cumbu isolates. All of them make very good growth on steamed rice. The grains turn purple, the sorghum strain producing dark purple pigmentation and the others lighter purple.

The pathogenicity of the isolates was tested by inoculation of different host plants. Spore suspensions were poured down the spindle and the plants were placed inside glass cages kept moist by spraying water twice a day. The results were as shown in the table following.

Suitable controls were kept and they remained healthy.

It can be seen from the results of the infection experiments that the three isolates of fungi bring about the death of their respective host plants in the young stage but on older plants the effect is not always fatal and more time is taken for infection. The sorghum and sugarcane isolates exhibit a greater pathogenic ability than the cumbu isolate. All the isolates gradually lose their virulence the longer they remain on culture media.

All the three isolates were inoculated on rice of the Gobikar variety. The grains were placed in spore suspensions under an exhaust pump for five minutes and then left for soaking for 24 hours. Afterwards the grains were sown in seedling pans containing sterilised soil. The seedlings remained healthy in all the pans thereby showing that none of the isolates is parasitic on Gobikar—a variety susceptible to 'foot-rot' caused by *F. moniliforme*.

Under field conditions the diseases on sorghum and cumbu have not been observed to be very extensive nor are the host plants

Source of isolate	Host inoculated	Result
Sorghum ..	Sorghum plants 1 month old	All plants killed in one week and fungus developed on central shoots.
	,, 2 months old	Central shoot rotted in 15 to 18 days.
	Sugarcane shoots 1 month old	Shoots killed and rotted in 20 days.
	,, 2½ months old	Reddish brown patches formed and tissues torn at the base of the blade.
	Cumbu plants 1 month old	Plants killed in 15 days.
Sugarcane ..	Sorghum plants 1 month old	The plants died and shoots rotted in 12 days.
	Sugarcane shoots 1 month old	Shoots killed and rotted in 15 days.
	,, 3 months old	Unfolding leaves with red brown patches and split at these places. No death.
	Cumbu plants 1 month old	Plants killed in 12 to 15 days.
Cumbu ..	Sorghum plants 1 month old	Central shoots discoloured and killed in 15 days.
	Sugarcane shoots 1½ months old	Reddish brown patches formed at the base of the unfolding, leaves in 12 days. No death.
	Cumbu plants 1 month old	Plants killed in 10 days.

usually killed. The disease becomes evident only during and after the rains and it is arrested on the advent of bright weather. The affected plants occur often in groups. A disease having symptoms similar to those of the sorghum disease described above has been noted on sugarcane in Cuba and is called 'twisted top' (Priode, 1929).[2] But it is said to be caused by mechanical friction of the leaves. The colour of the affected leaves is however stated to be similar to that of healthy leaves and there are no indications of rotting. Moreover it is said to be more severe during extremely dry periods. On the other hand, the diseases on sorghum and cumbu are accompanied by a certain amount of discolouration and rotting of leaves and occur only during the rainy months being absent during the dry season. Furthermore *F. moniliforme* has been always isolated from the discoloured portions of the leaves. The local disease of sorghum is hence different from the non-parasitic twisted tops of sugarcane in Cuba and is akin to the 'pokkah bong' of sugarcane caused by *F. moniliforme*. The fungus affects the leaves in the earlier stages which prevents their natural unfolding and the terminal portions of the leaves that come out later do not become freed but get entangled resulting in the series of arches. In cumbu the symptoms are more like those of 'pokkah bong' of sugarcane.

T. S. Ramakrishnan.

Agricultural College and
Research Institute,
Coimbatore,
July 14, 1941.

[1] Martin, J. P., *Hawaii Sugarcane Planters' Association*, 1938.

[2] Priode, C. N., *Phytopathology*, 1929, **19**, 343.

[3] Subramaniam, L. S., *I. C. A. R.*, 1936, *Bulletin*, No. 10.

THE OCCURRENCE AND INHERITANCE OF A BLOOMLESS SORGHUM

It has been recorded in a previous paper that all sorghums develop a waxy bloom and that the heavy bloomed condition (gene H) is a simple dominant to the sparse bloomed condition[1] (gene h). An examination of recent additions to the world collection of sorghums at the Millets Breeding Station, Coimbatore, showed that an African variety from Tanganyika by name *Vigage* (M.B.S. No. A.S. 4572)

belonging to the *Sorghum elegans* group was bloomless. In the least manifestation of the bloom the de-sheathed internode will show a little bloom. But A.S. 4572 was absolutely bloomless.

This rare type was crossed with both heavy bloomed and sparse bloomed types. In the former cross the F_1 was heavy bloomed and in the F_2, 252 plants were heavy bloomed and 84 absolutely bloomless. In the latter cross also the F_1 was heavy bloomed but the F_2 gave 108 heavy bloomed, 35 sparse bloomed and 43 bloomless plants, giving a 9 : 3 : 4 ratio. From this family 17 selections were carried forward and their performance is given below:

Family No.	Character of selection	F_3 behaviour		
		Heavy bloom	Sparse bloom	No bloom
A. S. 6752	No bloom	..	..	Pure
A. S. 6753	,,	..	..	Pure
A. S. 6754	,,	..	..	Pure
A. S. 6755	,,	..	..	Pure
A. S. 6749	Sparse bloom	..	Pure	..
A. S. 6751	,,	..	Pure	..
A. S. 6748	,,	..	93	36
A. S. 6750	,,	..	52	17
A. S. 6744	Heavy bloom	Pure	..	..
A. S. 6740	,,	99	34	..
A. S. 6745	,,	38	13	..
A. S. 6739	,,	77	..	26
A. S. 6741	,,	81	..	31
A. S. 6742	,,	97	..	32
A. S. 6746	,,	52	..	18
A. S. 6743	,,	69	21	29
A. S. 6747	,,	40	15	20

From the above table it will be seen that a gene designated Bm is responsible for the production of bloom in sorghum; bm gives an absolutely bloomless condition where the gene H has no visible expression. Seven selections in the above F_3 segregated for pithy and juicy stalks[2] also (genes D and d) and a cross collation showed an independent inheritance for bloom and for stalk juiciness genes. The total of the above segregations was, bloom-pithy 417, bloom-juicy 133, bloomless-pithy 141, and bloomless-juicy 50.

G. N. Rangaswami Ayyangar.
B. W. X. Ponnaiya.

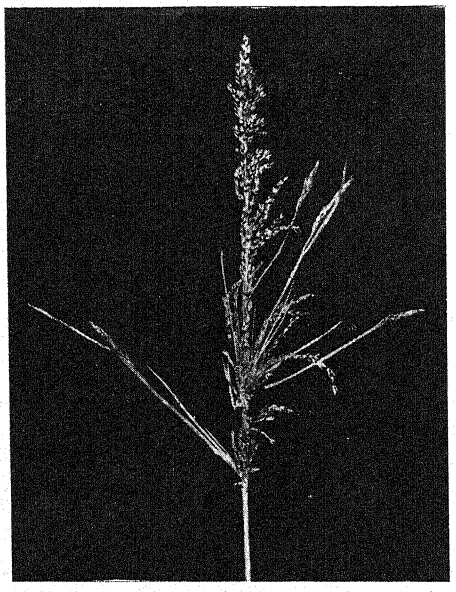
Millets Breeding Station,
Coimbatore,
August 8, 1941.

[1] *Proc. Ind. Acad. Sci.*, 1937, **5**, 4–15.
[2] *Madras Agric. J.*, 1936, **24**, 247–48.

THE OCCURRENCE AND INHERITANCE OF SHOOTS FROM THE AXILS OF PANICLE BRANCHES IN *SORGHUM SUDANENSE*

The rare occurrence of the e-ligulate and non-auriculate condition in the leaves of sorghum has been recorded. This has been noted to be a monogenic recessive to the normal ligulate and auriculate condition of the leaves. Non-auriculate plants lack the cushiony pulvinus at the base of the panicle branches.[1]

This note records an interesting sequel to the abnormal condition of e-ligulateness. In one e-ligulate type of *Sorghum sudanense* from Russia it was found that every panicle had side-shoots with two to three leaves and occasionally with tiny terminal panicles from the axils of panicle branches (see photograph). All the progeny exhibited this peculiarity in two successive generations. This type was crossed with a ligulate normal panicled type. The hybrid was ligulate and normal. In the F_2, no dihybrid ratios were obtained, there being only 229 normal ligulate plants and 74 e-ligulate plants with axillary shoots in the



Side-shoots from the axils of panicle branches in *Sorghum sudanense*

panicle. An F_3 generation was raised and in it, the three segregating families gave the following figures.

Selection No.	Character of selection	F_3 Behaviour			
		Ligulate		e-ligulate	
		No axillary shoots	Axillary shoots	No axillary shoots	Axillary shoots
S. 328	Ligulate no axiuary shoots	30	1	..	12
S. 329	,,	57	..	1	17
S. 330	,,	73	..	1	22
	TOTAL ..	160	1	2	51

From the above table it will be seen that there is a close linkage between the factor for e-ligulateness and the factor stimulating axillary shoots in panicles, there being a crossover value of about 0·01 per cent. It is interesting to note that in plants in which these shoots developed from the panicle axils, the axillary buds of the stem also were stimulated and gave many side-shoots. This teratological phenomenon has proved heritable.

G. N. RANGASWAMI AYYANGAR.
B. W. X. PONNAIYA.

Millets Breeding Station,
Coimbatore,
August 8, 1941.

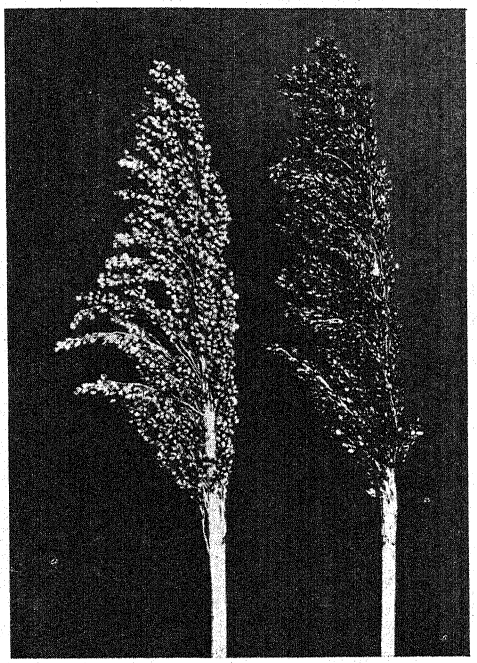
[1] *Proc. Ind. Acad. Sci.*, 1938, 7, 286–88.

TWO NEW GENES CONDITIONING THE TINT OF THE COLOUR ON THE GLUMES OF SORGHUM

THE glumes of sorghum are reddish purple, blackish purple or brown. Factors P and Q operate and give these three groups. The leaf-sheaths take on the same colour as the glumes.[1] A study of the vast collection of sorghums at the Millets Breeding Station, Coimbatore, reveals many tints on their glumes. Most of the tints remained constant in the progeny and it was obvious that there were other genes in addition to P and Q which were responsible for the tints. With a view to know more about these tints *Sorghum dochna* group was chosen as it exhibited a wealth of tints. In this group the glumes are very coriaceous with the added advantage of prominence due to the grain being almost enclosed and to the absence of transverse wrinkling. Most of the varieties of *S. dochna* have loose panicles and the spikelets get the best chance of exposure to light. The glumes are also very smooth and shiny and for these reasons the glumes of *S. dochna* afford the best theatre for the optimum manifestation of pigment on sorghum spikelets.

Two new types of purple on the mature glumes have been found and these have been termed "Dilute reddish purple" and "Dilute blackish purple" and are brought about by a single dilution gene. In a cross between a dilute reddish purple and a blackish purple type the F_1 was reddish purple. The F_2 generation gave 69 plants with the deeper tint (51 reddish purple, 18 blackish purple) and 20 plants with the dilute tint (16 dilute

reddish purple, 4 dilute blackish purple). In the F_3 generation the 4 dilute tinted selections bred true and of the 12 deep tinted ones 5 were pure. The remaining 7 segregated again giving a total of 883 deep and 277 dilute tinted plants. In 5 families there was also a segregation for reddish and blackish purple tints (genes Q and q); the total of the dihybrid ratio in these being 503 reddish purple, 172 blackish purple, 156 dilute reddish purple and 56 dilute blackish purple. Thus it will be seen that the



Sorghum panicles with Bleached and Unbleached glumes

gene for the dilution of colour in the glume (designated cd) is found to be independent of the gene Q. This gene dilutes the colour on the sheath also but not to the same degree as that on the glume.

The second gene inhibits the manifestation of the colour on the body of the glume and confines it to the very base. On a close examination, faint patches of colour may be noticed on the body of the glume but the total effect is one of bleaching (see photograph). The effect of the bleaching gene is noticed only after the dough stage of the grain. The colour instead of deepening does not develop but remains as a narrow band at the very base of the glume only. Thus even with the inhibition it is possible with experience, to separate reddish purple, blackish purple and brown groups with the aid of the basal band.

In a cross between two *S. dochna* types one bleached and the other unbleached, the F_1 generation had bleached glumes. The F_2 segregated giving 106 plants with bleached glumes and 35 plants with unbleached glumes. Sixteen selections were carried forward and an F_3 generation raised. Of these 3 bleached glumes bred true and 6 segregated giving a total of 559 plants with bleached glumes and 188 with unbleached glumes. The remaining seven unbleached glume selections bred true.

From the above it will be seen that a dominant gene Ci is responsible for the inhibition of colour and the bleached appearance of the glumes in sorghum. The gene has no effect on the leaf-sheath colour. The gene R responsible for the red sap colour in sorghum[2] has its effect on the appearance of the bleached glumes also. With R, the bleached glume puts on a pinkish wash.

It will be seen that in addition to P and Q genes, (responsible for reddish and blackish purple) two new genes cd (dilution gene) and Ci (bleaching gene) affect the tint of colour on the glumes of sorghum. The many possible combinations of these genes provide a variety of glume tints. These are again affected by the gene R determining the red in sap colour. The numerous glume colours enumerated by Snowden[3] in the classification of sorghums could be explained against this genic background.

G. N. Rangaswami Ayyangar.
B. W. X. Ponnaiya.
Millets Breeding Station,
Coimbatore,
August 8, 1941.

[1] *Ind Jour. Agric. Sci.*, 1933, **3**, 489–94.

[2] *Madras Agric. J.*, 1934, **22**, 1–11.

[3] Snowden, J. D., 1936, *The Cultivated Races of Sorghum*.

KERNELS OF *THEVETIA NERIIFOLIA* JUSS.—A POTENT INSECTICIDE

INVESTIGATIONS were recently started at the Entomological Laboratory, Agricultural College and Research Institute, Coimbatore, to determine whether indigenous vegetable poisons could subserve as potent insecticides as well. The existence of contact insecticidal properties of a high order in the seeds of *Thevetia neriifolia* Juss. has come to light. Aqueous infusions were found to be toxic against insects infesting plants. These were prepared by soaking mashed kernels in water for 24 hours and filtering the extract. It was then sprayed with the addition of an equal quantity of soft soap. Trials against caterpillar pests such as *Prodenia litura* F., *Papilio demoleus* L., *Deilephila nerii* L., *Spodoptera mauritia* B., *Laphygma exigua* H.B., *Eupterote mollifera* W., *Euproctis* sp., etc., and bugs of different species of Aphids, Tingids and Psillids have given very satisfactory results. The optimum concentration for getting a high mortality in most of these insects would appear to be ¼ to ½ oz. of the kernel in one gallon of water (0·16% to 0·31%). Mealy bugs like *Pseudococcus virgatus* C. and hard-boiled scales like *Saissetia nigra* N. however, require higher concentrations varying from one to two ounces per gallon. With the added advantage of its cheapness and easy availability, this vegetable poison is bound to prove an important source of a very effective insecticide. Further studies are in progress.

M. C. CHERIAN.
S. RAMACHANDRAN.

Agricultural Research Institute,
Coimbatore,
August 30, 1941.

GENETICAL STUDIES OF ERI SILKWORMS—(*ATTACUS RICINI* BOISD)

IN a consignment of live Eri silkworms received from the Silk Farm, Coonoor, two different types of worms were met with. While both were similar in size, colour, position of setæ, etc., one had prominent black spots on the body (Fig. 2) while in the other the black spots were absent (Fig. 1). To find out whether this variation was brought about by differences in sexes the two types of caterpillars were sorted out, fed separately and allowed to pupate. When the moths emerged both sexes were found in both the groups and they were phenotypically alike. Their breeding behaviour was then observed. Eventually moths from the

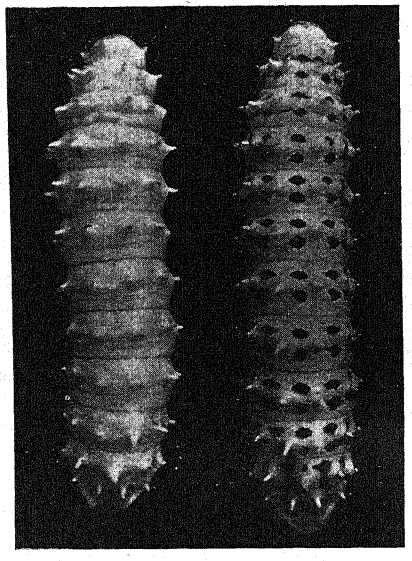


FIG. 1 FIG. 2.

'spotted' were crossed with those from the 'non-spotted'. F.1s were all spotted. In the F.2s spotted and non-spotted segregated in a simple monohybrid ratio (245 : 84). This was further confirmed by the results obtained by back crossing the F.1 with the recessive (177 : 162). It was concluded that spotted character in Eri silkworms is controlled by a simple pair of Mendelian factors (S, s) spottedness behaving dominant.

M. C. CHERIAN.
V. MAHADEVAN.

Entomological Laboratory,
Agricultural Research Institute,
Coimbatore,
August 30, 1941.

EFFECT OF STORAGE ON THE QUALITY OF PONGAMIA OIL

THE solid deposit from pongamia oil was reported to contain zinc salts of higher fatty acids and practically all the karanjin of the oil.[1, 2] Experiments regarding the origin of the zinc and the conditions promoting the precipitation of karanjin have subsequently been made and the results are presented here.

A careful examination of the oil, of the seed cake and of the seed showed that no zinc was present in them. Obviously, therefore, it should have come from outside and the container should have been responsible for it. In our previous experiments it happened to be made of galvanized iron and we presume that the case was similar with the experiments of Manjunath and Rao. In a recent communication,[3] Jones and Haller have reported the presence of zinc in stored products and have isolated the zinc compound of bi-eugenol from commercial geraniol. With a view to make the position sure, samples of freshly-expressed pongamia oil were stored under similar conditions in glass bottles and in galvanized iron containers. In the first case even after five months there was no deposit whereas in the second case appreciable quantities were obtained even within a month and the bulk of the deposit increased rapidly with time. It was further noticed that within the first two months the solid consisted mostly of zinc salts and only later on the precipitation of karanjin took place. It seems to be clear, therefore, that the hydrolysis of the fatty oil is initiated and enhanced by the presence of zinc and that it is the first step in the changes taking place. The liberated acids combine with zinc to form the zinc salts and also cause the precipitation of karanjin. The last point was established by working with the oil present in glass containers and adding small quantities of glacial acetic acid. Karanjin began to separate in the course of a few hours and was complete in a few days. The precipitation was considerably enhanced by keeping the oil cooled in ice and shaking occasionally. With 3 per cent. addition of acetic acid, about 3 days was found to be enough for the separation of most of the karanjin. The substance was quite pure and unmixed with any solid fatty acid. It could therefore be concluded that it is necessary to store the oil in glass containers in order to avoid rapid deterioration in quality and if quick separation of karanjin is desired, addition of an organic acid like acetic acid would be very helpful.

N. V. SUBBA RAO.
T. R. SESHADRI.

Andhra University,
Waltair,
August 15, 1941.

[1] Manjunath and Rao, *J. I. C. S.*, 1938, **25**, 653.

[2] N. V. S. Rao and T. R. Seshadri, *Curr. Sci.*, 1940, **9**, 76.

[3] Jones and Haller, *J. A. C. S.*, 1940, **62**, 2558.

A MARGOSA TREE WITHOUT THE BITTER PRINCIPLE

IN a note appearing in a recent number of *Current Science*[1] Mr. Cherian Jacob has described an extremely interesting association of a margosa and banyan tree, in which the bitter principle of the margosa has been found lacking. The reasons adduced by the author to explain this phenomenon are untenable. The terms 'stock', 'scion' and 'grafting' have been used in a rather loose way. While there is no record of any vascular connection in epiphytes with the host tissues, it is difficult to determine the stock and scion in independently rooted plants. If the banyan tree could draw out the bitter principle, it would indeed be interesting to know whether the banyan leaves developed the bitter principle in them.

In this connection the writer wishes to mention that margosa trees without the bitter principle have been known to occur in many places. A margosa tree near Mandya, Mysore State, is an object of worship on account of

the fact that in one of the branches overhanging the walls of a temple, the leaves are devoid of the bitter principle, while the rest of the tree bears bitter leaves. This margosa tree is not found in association with banyan or any other plant.

It is quite manifest that the absence of the bitter principle is due to some changes other than the 'stock' influence of the banyan. The author mentions that it is not a genetic modification because the seedlings had leaves with the bitter principle. It would have been more convincing if observations were made in plants propagated from clones.

M. J. THIRUMALACHAR.

Department of Botany,
Central College,
Bangalore,
August 19, 1941.

[1] *Curr. Sci.*, 1941, **10**, 335.

I WAS much interested to learn of the occurrence, in Mandya, of a margosa tree, in which one particular branch bears leaves devoid of the bitter principle.

My object in publishing the note in the July number of *Current Science* was only to bring to the notice of the workers, about the existence of an interesting tree combination. I suggested that the banyan tree might have originally started as an epiphyte and later by the peculiar circumstances of growth described in the note, there is every reason to believe that some parts at least of the two trees might have fused, and the banyan being now a much bigger tree might be influencing the margosa. I did not examine any section to find out whether there is any real fusion. I leave that for future workers. I do admit that the terms, stock and scion, have not been used in the scientific sense of the terms; they were used more with a view to connote the union of the two trees. It would certainly be interesting to study the behaviour of the seedlings raised from the seeds of the parent margosa tree. But I have no doubt that the seedlings found under the banyan-margosa tree combination are from the seeds of this margosa tree.

The suggestion I have made in my original note will stand, until definite evidence to the contrary is forthcoming. A critical examination of the Mandya tree and also of other trees without the bitter principle occurring "in many places" will undoubtedly be of much interest. When I was touring in Chingleput District in the Madras Province it was brought to my notice that a mango tree within the precinct of the Conjeevaram temple bears different kinds of fruits on the four sides of the tree. I examined the plant in question and found that the so-called single tree was the combination of at least two different varieties planted close to each other and now appear to have only one main stem.

K. CHERIAN JACOB.

Agricultural Research Laboratory,
Lawley Road P.O.,
Coimbatore,
September 3, 1941.

REVIEWS

Temperature—Its Measurement and Control in Science and Industry. (Reinhold Publishing Co., New York), 1941. Pp. xiii + 1362. Price $11.00.

The first statement of the Foreword that "This book is the record of a 'Symposium on Temperature—Its measurements and control in Science and Industry' held .... under the auspices of the American Institute of Physics" .... perhaps represents the best review of the work. As a matter of fact it can hardly be described as a "book", for neither has it been written in that form nor does the subject-matter covered lends itself to be treated in a book form of the conventional type. It is simply a collection of papers embodying the results of numerous investigations presented at the symposium, and as such forms an excellent reference volume on the subject of temperature control and measurements in diverse fields including theoretical and experimental physics, applied and industrial chemistry, engineering and metallurgy, natural sciences, biology and physiology, etc., etc.

The measurement and control of temperature is one of the subjects which pervades almost all industrial operations and on it depends the success or failure of an industry and the quality of the product. In spite of the great importance of the subject, and the advances made in it in the past few years, it has not received as much attention as it deserves as a separate subject. The American Institute of Physics is to be congratulated for having conceived the idea of such a symposium for having carried it through to its logical conclusion.

Some 125 papers representing the work of at least a similar number of authors contained in the volume have been grouped under thirteen different headings, which it may not be out of place to repeat here:

(1) Temperature and Temperature Scales. (2) Precision Thermometry. (3) Education. (4) Natural Sciences. (5) Temperature in Biology. (6) Temperature and Its Regulation in Man. (7) Automatic Temperature Regulation and Recording. (8) Special Application and Methods. (9) General Engineering. (10) Metals and Ceramic Industries. (11) Oil Industries. (12) Optical and Radiation Pyrometry. (13) Thermometric Metals and Alloys.

The papers and their discussions are followed by an Appendix containing 25 tables of useful data, a glossary giving definitions of technical terms and two very comprehensive indexes. The book is well printed, but the bulk of it suggests that it might have been conveniently split up in two separately bound volumes.

It is not possible in the course of a short review to do full justice to this comprehensive collection of papers containing the most up-to-date information on the subject. Suffice it to say that no individual or institution interested in any branch of science, pure or applied, covered by or related to those listed under the thirteen items above, can afford to miss this publication.

LAL C. VERMAN.

Air and Its Mysteries. By C. M. Botley, with a Foreword by Sir Richard Gregory. (The Book Club, London), 1940. Pp. 266. Price 2*sh.* 6*d.*

The book is not a text-book. It is intended to be of use to the lay reader in this air-minded age to enable him to appreciate some of the marvels of the atmosphere. The reader starts on his tour into the realms of the atmosphere in the first chapter on "The Ocean of Air". In the next 8 chapters he makes acquaintance with matters meteorological such as the composition of the atmosphere, the wind circulation, the clouds, the different manifestations of water vapour and its forms of precipitation, thunderstorms, the optical phenomena in the atmosphere and the science of weather and climate. A chapter on "The Realm of Sound" gives him later an idea of the properties of the atmosphere in relation to sound waves, including the interesting phenomena of the zones of silence. Then follows a chapter on "The Highways of the Air" in which the reader learns of the mechanism of the flight of birds, insects and the gliding mammals, as well as man's failures and successes with balloons, airships and aeroplanes. The last chapter "Towards the Unknown Region" opens a fascinating vista. It gives one a glimpse of the progress of knowledge about the regions in space

around the earth from the days of Wilson and Melville of Glasgow when they first raised thermometers with kites in 1749, down through the period of Glaisher, Tissandier and other pioneers, right to Piccard and Millikan. The chapter also gives the reader some idea of radio-sondes, cosmic rays, ozonosphere and the ionosphere, as well as of the enthralling manifestations of the auroras.

The style is easy, straightforward and particularly pleasant, because of the historical background, literary allusions and artistic touches that one finds interspersed in a large collection of scientific facts. The format is good; there are hardly any printing mistakes. The only two blemishes that the reviewer noticed were a mis-print of "weigth" for "weight" on page 5, and the total absence of the frontispiece of an Antarctic scene of optical phenomena referred to on page 87. The book contains 16 beautiful plates from photographs and over 20 text-figures. But the Index is not as full as one would wish.

On reading the book, one is reminded of D. Brunt's "Weather Science for Everybody" (1936) which presents meteorology, also to the lay reader, in a more formal manner. Besides the general reader, Miss Botley's book could be useful also to High School students whose curriculum may include physical geography, covering elementary meteorology. For these students, if Brunt's book were to serve as a text-book, Botley's book could form an excellent supplement for "rapid reading". V. V. SOHONI.

Practical Solution of Torsional Vibration Problems. By W. Ker Wilson. Second Edition, Volume I. (Chapman & Hall, Ltd., London), 1940. Pp. xx + 731. Price 42*sh.*

There is no doubt that at the present time Engineers are realising more and more that the study of vibration is an accompaniment of sound design. This is especially true of Torsional Vibration as it does not exhibit any external symptoms of approaching destruction, as can be usually noticed with other forms of vibration.

Since the author published the first edition of this book in 1935, considerable progress has been made in the study of torsional vibration, and this has necessitated his rewriting a major portion of the original text and adding several new chapters.

In this, the first of the two volumes of the second edition, a large amount of new practical design data has been added and high speed engine systems have been treated more comprehensively. The earlier chapters deal with the fundamentals of torsional vibration, with the calculations of natural frequency and with equivalent oscillating systems in a very thorough manner. The study of flexible couplings occupies one very large chapter, special attention being drawn to the use of rubber as a structural material in rubber-in-shear couplings under the heading "Geared Systems" considerable addition has been made and the treatment of geared engines supported on flexible mountings and of high frequency tuning as a method of solving vibration problems, are of special importance. Of particular interest also is the study of Aero engine and Air screw installations and of vibration absorbers, specially the rotating pendulum absorber which is considered to be "one of the most valuable contributions to aircraft engine design in many years". The introduction of this pendulum absorber has considerably reduced the wear on the engine parts and the operating mechanism of the variable pitch air screws.

The attempts made in recent years to assess torsional vibration stresses in resonance and to draw up reliable empirical formulæ based on test results have prompted the author to include in this volume a description of the accurate instruments which have been developed for measuring torsional vibration frequencies and amplitudes of all types of engines and installations, including the latest types of electrical measuring instruments also. The theory of these instruments is discussed in full and the methods of calibration also given.

The text is profusely illustrated with worked numerical examples and this enhances the value of the book as an aid to the designing engineer. E. K. R.

The Social Life of Animals. By W. C. Allee. (The Scientific Book Club, London), 1941. Pp. xiv + 261. Price 2*sh.* 6*d.*

This interesting book ably maintains the excellent standard set up by its predecessors, which the Club has been issuing since its inception. The book contains quite a large mass of material which will entertain and stimulate the professional biologist and the lay reader alike. Professor Allee is

well known for his investigations on the group behaviour of animals, and this is a branch of study whose fascination and general implication have recently recruited a large number of scientists trained in the analytical and statistical methods of work.

We have some exceedingly able treatises dealing with the mysteries of animal behaviour and Professor Allee's book will rank high in the series. Though the actions of animals sometimes seem easy to comprehend, the lower we go down in the scale of life, the mystery becomes almost bewildering. Have the animals the faculty of reason? How do they act with purposiveness? The answer has been "by instinct". Does the theory of *instinct* apply to man? It would appear that all animals including man behave in the generality of cases like automata, equipped with a nervous mechanism enabling them to act in a particular way in a given situation. This is the mechanistic conception or explanation of the behaviour of animals, but it is possible to demonstrate by carefully planned experiments that behaviour patterns are subject to psychological laws governing animal nature, and the possibility of endowing animals with the faculty of adjusting their actions, due to the promptings of free will, amounts to an inescapable doctrine.

For over thirty years Professor Allee has been engaged in exploring the group behaviour of animals, which formed the subject of his Norman Wait Harris lectures at North-Western University, and this book has grown out of these lectures. "I make no effort to pose as the remote purveyor of a mysterious erudition; I could not in any case regard myself as more than the exponent of the glorified common sense which I more and more firmly believe all science should be." This is modesty but it does not preclude the author from presenting to the reader a fairly comprehensive fare, rendered palatable by his lucid and amusing style. Dealing with the particular line of group organisation usually known as "peck order" in chickens, the author writes, "putting the matter somewhat facetiously, chickens appear to have developed the sort of line organization characteristic of a military system or a fascist state, while pigeons, together with the ring doves, canaries and parakeets are more democratic". He accordingly derives the hypothesis that "social organization observed in birds and other animals reminds one almost constantly of certain types of human situations ..... it may well be that the social hierarchy of chickens, canaries and men must have much in common". The reader will find that the principal thesis of the book is to reveal a gradual development of social attributes, originating in the lower animals in simple forms and culminating in coupled tendencies in the higher mammals, thus having a common substratum for all types of behaviour patterns. This extraordinarily interesting phenomenon is dealt with in six chapters commencing from the third.

This book, at once scholarly and humorous, will form an important contribution to biology, the cultural value of which can hardly be exaggerated. It is illustrated by numerous figures, diagrams and graphs, and is provided with an extensive bibliography which enhances its usefulness to students who wish to acquire more information than is provided by the book. Great care has been taken with the arrangement of the material and the effect is that the reader is offered a constructive argument and a comprehensive picture.

Sons of the Soil, *Studies of the Indian Cultivator*. Edited by W. Burns, Agricultural Commissioner with the Govt. of India. (Manager of Publications, Civil Lines, Delhi), 1941. Pp. 128 + 44 plates. Price Rs. 2–6–0 or 4*sh*.

A series of pen pictures of the different types of the Indian cultivator drawn by several authors have been brought together under the editorship of Dr. W. Burns, Agricultural Commissioner with the Government of India, and published under the above title. The types brought together are very varied and represent cultivators from many different parts of India; there is as much diversity as can be seen in the picturesque crowds of *mela* and the descriptions form both entertaining and instructive reading. Few people see the cultivator in his village and fewer still know anything of him other than as a type, half-clad, poverty-stricken, quarrelsome, insatiably fond of litigation and the law court, ignorant, immeasurably in debt, conservative to a degree, thriftless, improvident and so on. To these the book will come as an agreeable surprise, for the type is here resolved into the individual clothed in flesh and blood and seen in his

home, on his field, in the midst of his family, his oxen and his sheep, his temple, his priests, his feasts and fasts and festivals as a man with virtues to praise and weaknesses to pity, the man as apart from the "guinea stamp" and who is "the gow'd for a' that". The group is very comprehensive; there are Afridis, Pathans and Baluchis, adepts with the gun as with the plough; there are other warrior cultivators, Panjabis, Jats, Scindhis, Moslems from the U.P.; there are the men from Assam, Bengal, Bihar, Orissa; cotton cultivators from the typical cotton tracts of the Berars and Maharashtra; Madrasis and Burmans; there are men wedded to the land and there are aboriginal tribes with their shifting cultivation; there are the prosperous looking men in very consequential attire and there are men exhibiting their manly frames as God made them; bright open faces of the boy cultivators alongside the furrowed crows'-footed faces of these old "horny-handed sons of toil", showing what this ancient craft can do to the "human face divine". What kind of house does he live in, what does he eat, how much or how often, what are his clothes, his furniture, his utensils, what is his daily routine, what are his amusements, his pleasures, his domestic cares, the codes of his caste or his religion, the customs at marriages, feasts or funerals—to these and similar questions the reader will find an interesting variety of answers. Not the least entertaining part of the answers is the lore of proverbs, which so pithily sum up the hoary wisdom of the cultivator, so helpful, so amusing and so illuminating. The womenfolk come in for a goodly share of the descriptions; they are worthy helpmates as much in the field as in the home, who are often shrewder and better able to drive a bargain than the brawny male. The book is illustrated with a fine set of photographs of the different types which lend very great charm to the book. As an entertaining little book on the ways of the Indian ryot and, we may add, of his wife, the volume is a little gem.

A. K. Y.

CENTENARIES

Paracelsus (1490-1541)

PARACELSUS, a German physician, was born in Einsiedaln about 1490. His surname was Hohenheim; but he gave it up for the one of his own making. At a comparatively early age he questioned what was taught to him in Medicine by his father and struck out new ways himself. He did similarly when he entered the university of Basel. He left school chemistry and started for the mines in Tirol and preferred to learn by going to nature herself. He then went wandering over a great part of Europe. The book of nature, he affirmed, is that which the physician must read. Though others called him an ignorant vagabond, he himself valued his knowledge differently and wrote "Whence have I all my secrets, out of what writers and authors? Ask rather how the beasts have learned their arts. If nature can instruct irrational animals, can it not much more men?" He had thus acquired great stores of facts which gave him an unquestionable superiority to his contemporaries. So in 1526, on his return to Basel, he was appointed town physician and a lecturer in the University.

He broke away from tradition. His lectures were in German and not in Latin. They were expositions of his own experience and of his own methods of curing and were not commentaries on the text of Galen. For a couple of years this new venture brought him reputation and practice. But in due course jealousy and enmity gathered sufficient momentum to drive him away and he ended his life in a miserable way.

For centuries he was evaluated in every possible way. But now it is acknowledged that his vigorous attacks on the degenerate Galenism of his day helped the foundation of modern scientific medicine. His *Chirurgia magna* went through ninteen editions and translations into several languages. He is credited with the discovery of the inherited characters of syphilis. He protested against the excessive blood-letting in vogue at that time. It is claimed that he was one of the first to bid modern Europe think for a moment upon the idea that diseases are inflicted neither by saints nor demons. Thus and in several other ways Paracelsus helped the downfall of the scholastic medical science of his time.

Paracelsus died at Selzburg 24 September 1541.

De Candolle, Augustin Pyramus (1778-1841)

AUGUSTIN PYRAMUS DE CANDOLLE, a French botanist, was born at Geneva 4 February 1778. Having had his education at the college of Geneva, he went to Paris in 1796 and became a favourite pupil of the botanist, Desfortaines. In 1808 he became pro-

fessor of botany and director of Botanic Garden at Montpellier. In 1816 he resigned his offices and came to Geneva whose citizens founded a chair for him in 1817.

Histoire des plantes grasses (1799–1803) was his first book. His doctorate thesis was an *Essay on the medicinal properties of plants* (1804). He revised Lamarck's *Flora of France* (1805). His *Theorie elementaire de la botanique*, which is remarkable for its profoundness and which is regarded as his masterpiece came out in 1813. His *Regni vegetabilis systema naturale* (1818–21) had to be discontinued after the second volume as its plan was too vast for one man to execute. In 1824 began a more modest version under the title *Prodromus*. But even this had to be completed only after his death, by his son and other botanists. His *Organographic vegetale* (1827) dealt with the anatomy of plants and developed the doctrine of metamorphosis. This was followed in 1832 by a book on the physiology of plants.

While every botanist had yielded to the influence of the artificial system of Linnaeus, De Candolle was the first to estimate its merits correctly. In the principles of classification expounded by him in his introduction to Lamarck, he said "The natural method endeavours to place each individual object in the midst of those with which it possesses the greatest number of points of resemblance; the artificial has no other end than that of enabling us to recognise each individual plant. ... The former being truly a science, will serve as an immutable foundation for anatomy and physiology, to build upon; whilst the second ... does nothing towards enlarging the boundaries of science."

After a visit to a meeting of naturalists at Turin, De Candolle died 9 September 1841.

S. R. RANGANATHAN
University Library,
Madras.

SCIENCE NOTES AND NEWS

Contact Angles.—An interesting method for measuring contact angles has been described by Bikerman (*Ind. Eng. Chem.*, Anal. Edn., 1941, 13, 443) making use of the equation

$$\frac{\Delta_0^3}{v} = \frac{24 \sin^3\theta}{\pi (2 - 3\cos\theta + \cos^3\theta)}, \text{ where}$$

Δ_0 = the diameter of a minute droplet of the liquid,

v = the volume of the drop, and θ = the contact angle between air, liquid and solid.

A microsyringe is used to produce very small drops while their volume is determined by a micrometer syringe. The diameter of the contact circle is determined by measuring the diameter of the mark produced after evaporation of the liquid drops using a suitable travelling microscope. The method described, is used to measure the contact angle for water drops on built-up multilayers of soaps, on lacquered tin plate and on glass plates. The method seems to be simple as it involves the measurement of length and volume and not of the angle and the results obtained represent a more accurate average value for the contact angle. M. R. A.

Particle Size Determination by Sedimentation.—Sedimentation methods offer a means of obtaining the size distribution curves of soils. Wiegner, Kelly and others developed a simple method which consists in measuring the change in hydrostatic pressure exerted by the suspension as the suspended material separates. It was observed that the liquid from the manometer capillary entered the settling tube thereby causing a disturbance in the suspension. Kammermeyer and Binder (*Ind. Eng. Chem.*, Anal Edn., 1941, 13, 335) have improved it by using an all-glass manometer. A spoon gauge made by elongating a thin-walled bulb and then flattened on one side has been used to measure the pressure differences. The pointer movement is amplified by optical arrangements. Calibration curve is got by converting the increases in height of the liquid to increases in pressure and plotting against pointer displacements. The advantages of this method are: (1) that the final position of the pointer can be easily calculated which corresponds to complete settling, (2) disturbances caused by the flow of the liquid from the side arm are avoided and (3) a closer differentiation of particle sizes is possible owing to the high sensitiveness of the all-glass manometer. G. S.

Passivated Tinplate.—When sulphur-containing food-stuffs are packed in tin-plated cans, the insides of the cans generally become stained during the hot sterilising process. In addition, the artificial colouring matter added to certain food-stuffs get bleached by reduction by the tin. A special sulphur-resisting lacquer is often applied to the tinplate to avoid these difficulties. An alternative and simpler method of protection is described by R. Kerr in *The Tin Research Institute Publication* No. 104. This consists in passivating the tinplate with an invisible oxide film produced by treatment with a solution which is both alkaline and oxidising and contains, essentially, trisodium phosphate and sodium dichromate. Full details are given in the publication. M. A. G.

Chinese Amphibians and Reptiles.—South-eastern China has been very little explored from a herpetological point of view and for this reason the collection of Amphibians and reptiles made and described by J. L. Gressitt (*Philippine Journal of Science*, May 1941, 75, No. 1) is interesting. The collection has

been made in three provinces of south-eastern China, *i.e.*, Kiangsi, Kwangtung and Fukien and extend over varying altitudes. The specimens fall under 63 species, including one urodele, 24 species of Anura, 6 lizards, 25 snakes and 7 turtles. In this collection has been reported one species of snake, *Natrix boulengeri* which is new to science but it includes a number of species of both amphibians and reptiles which have been taken in these provinces for the first time. No Apoda are reported from the area but one species of newt, *Pachytriton brevipes* occurs in Kwangtung province at an altitude of 640 metres in fresh-water pools and streams. It is of interest to note that a number of Indian forms occur in this part of China, notably species of *Bufo* (*B. melanostictus*), *Rana* (*R. limnocharis*), *Kaloula* (*K. pulchra*), *Microhyla* (*M. ornata*) and a number of turtles and snakes.

Chromite in Mysore.—Mysore State is one of the chief centres of chromite ore production in India. It contributes nearly one-half, and Baluchistan one-third, of the total Indian output. Mysore's total is roughly two and a half per cent. of the entire world production. In a bulletin issued for the benefit of the general public (*Mysore Geological Dept. Popular Studies No.* 2) Mr. Venugopal explains in detail the nature of occurrence, origin and distribution of chromite deposits in the State.

Workable deposits of chromite occur only in Hassan and Mysore Districts. In the former the chief productive mines are situated near Chokenhalli, Bhaktarhalli, Jambur and Byrapur on the Nuggihalli Schist belt which extends roughly from Nuggihalli to Arsikere. The Byrapur mine alone has yielded upto 1937, 60,000 tons of ore valued at Rs. 11 lakhs. In the Mysore District the only mine of importance is Shinduvalli which produces annually 2,000 tons of chromite. N. JAYARAMAN.

Substitutes for Mineral Oils.—The Board of Scientific and Industrial Research have suggested certain vegetable oils or vegetable-mineral oil mixtures as substitutes for mineral oils.

It is understood that the Inspectorate General of Stores, Cawnpore, is prepared to undertake testing of these oils. The Inspectorate is being expanded to include a Lubricant Section which, when properly equipped, will be able to undertake testing of all lubricants, including aero-engines lubricating oils required by the Defence Services. It will also test oils on behalf of the Civil Services.

The Kalabagh Barrage which is now under construction is situated on the river Indus. Its purpose is to divert water for the irrigation of the Thal area.

The catchment area of the Indus above Kalabagh is 111,900 square miles and the barrage is designed to pass a discharge of 950,000 cusecs. Sufficient freeboard is, however, provided to permit 1,100,000 cusecs to pass with safety.

There is a possibility of this discharge being experienced in the event of the Shyok glacier dam forming again and bursting simultaneously with a high flood. As a result of the bursting of the Shyok Dam in 1929 exceptionally serious floods were caused in the Punjab and the North-West Frontier Province. About 225 lives were lost and thousands of houses and head of cattle destroyed in nine districts of the Punjab. There was also loss of life and enormous destruction in some districts of the Frontier Province.

The Barrage, which is founded on a mixture of sand, shingle and boulders is designed for a maximum head of 22 feet which allows for 2 feet of retrogression downstream. It is 3,781 feet long between abutments and comprises a central weir section consisting of 42 bays of 60 feet each with an undersluice section at each end consisting of 7 bays of 60 feet each. All bays are provided with gates. The gates and gearing are being manufactured by the Central Canal Workshops at Amritsar.

The estimated cost of the Barrage is Rs. 1,75,00,000.

Forest Research Institute.—All the member mills of the Indian Paper Makers' Association have agreed to a voluntary cess of four per ton of output, based on the audited statements of the production of the mills in order to finance the researches carried out in the Paper Pulp Section of the Forest Research Institute, in the general interest of the industry. According to a report appearing in the *Indian Forester* (1941, 67, 498) a committee has been appointed to function in an advisory capacity in matters relating to research work, undertaken at the Forest Research Institute, either on its own initiative or at the instance of the member mills. At the first meeting of the Committee held at Calcutta on March 8, it was agreed that the Paper Pulp Section staff should undertake an investigation relating to the possibility of eliminating silicious scale occurring on the surface of bamboos, which appears to be unaffected by digestion or bleaching and which appears to be one of the primary causes of dirty bamboo pulp. A small technical sub-commitee was formed to consider and adopt a scheme to standardise tests and testing apparatus for paper and pulp and also to consider standards for testing the various raw materials found in India. Among other important decisions reached, mention may be made of the following: (1) a scheme in paper technology for workers in paper mills, and (2) building up a reference library at Dehra Dun for the use of those interested in the paper and pulp industry.

With a view to having closer co-operation and co-ordination between the manufacturers and research institutions, the **Indian Chemical Manufacturers' Association** has approached important Universities in India carrying on research with a request to include representatives of manufacturers of chemicals and drugs on the Advisory Boards of the Universities. It is pointed out that association of manufacturers with Advisory Boards would enable them to give their suggestions about researches that would be useful to the Industry, as it often happens that researches

are being carried out on products which are already being manufactured in the country or which could not be economically manufactured. Moreover, the manufacturers would be able to keep themselves in touch with the researches that are being carried out in the laboratories under the Universities.

Indian Central Jute Committee.—At the meeting of the Committee held on Friday, July 25, the following schemes of research were sanctioned: (1) Preparation of synthetic resins and plastics in soluble or emulsion form, suitable for impregnating bleached jute fibre with a view to improving its qualities, (2) investigations on the chemical utilisation of jute and jute waste, and (3) researches into jute fibre when treated with plastics. Experiments contemplated in this connection include the use of jute twine in the manufacture of camouflage nets, the possibility of manufacturing all-jute fabrics for canvas and other military needs.

A sub-committee was appointed in this connection, to draw up a detailed programme of work on plastics in which the respective parts that the *Board of Scientific and Industrial Research*, the *Indian Lac Research Institute* and the universities could play in this matter was to be clearly indicated. The sub-committee will consist of Sir S. S. Bhatnagar, Dr. H. K. Sen, Mr. I. G. Kennedy, Dr. W. G. Macmillan, Prof. B. C. Guha, Mr. C. R. Nodder, Mr. Padampat Singhania, Mr. Priya Nath Sen and Dr. M. N. Saha. To the same Committee was also entrusted the task of formulation of a programme of work for the Technological Research Extension Scheme.

A scheme (by Prof. B. C. Kundu) on the study of the growth and development of the jute fibre, and a scheme (by Dr. B. C. Guha) for biochemical investigations of the processes involved in the retting of jute were approved.

An important step in the progress of agricultural research on jute in Bengal was signalized by the opening of a Research Station at Konda, a village in the Brahmanbaria Sub-Division of the District of Tipperah, on the 19th August. The opening ceremony was performed by Mr. O. M. Martin, C.I.E., I.C.S., Commissioner, Chittagong Division. In the varying conditions of soil, water and climate in which the jute crop is grown in Bengal, it is necessary that agricultural research work on jute, particularly in its more practical aspects, should be decentralised and replicated at selected centres, spread over representative jute-growing areas. The research centres are intended to serve as a link between the Committee's research activities and the practical needs of the cultivators.

A Charter for Science.—The London correspondent of the *Hindu* reports: "At the Royal Institute on September 26, under the auspices of the Ministry of Information and with the support of the British Association, a world conference on science and world order will be opened.

"Explaining the object, Sir Richard Gregory, President of the British Association, said that science could be used for good or evil and the time has arrived when scientists, who themselves constituted a democracy that knew no distinctions of race, colour or creed should determine how their work should benefit, not injure humanity. The main theme of the Conference would be the use of science for constructive not destructive purposes. They hope to devise a charter to which all scientists could subscribe and reach decisions that would keep science from the hands of gangsters who used it to wreck society.

"Prof. Einstein will address the Conference by radio on 'The Common Language of Science".

Unviersity of Mysore.—A meeting of the Academic Council was held on the 30th August in Bangalore.

The following extension and special lectures were delivered during the month of August 1941: (1) Mr. A. Narayana Rao, "Some aspects of animal life". (2) Dr. R. E. Heilig, "Vitamins and preservation of health". (3) Dr. R. Balakrishna, "Industrial Development of Mysore". (4) Mr. A. V. Telang, "Separation of electric charges in the atmosphere". (5) Mr. C. V. Srinivasa Murthy, "The evolution of moral values". (6) Mr. B. Kuppuswamy Naidu, "The inheritance of mental ability". (7) Mr. R. L. Narasimhia, "Inaudible sound".

MAGNETIC NOTES

The average magnetic activity in the month of July 1941 was slightly less than that in the preceding month. There were 3 quiet days, 18 days of slight disturbance and 7 of moderate and 3 of great and very great disturbance as against 3 quiet days, 20 days of slight disturbance and 1 of moderate disturbance. The day 5th July 1941, was very considerably disturbed and the 27th the least. The character figures of individual days in July 1941 are given in the following table:—

Quiet days	Disturbed days		
	Slight	Moderate	Great and very great
19, 26 & 27	1, 2, 3, 13, 14, 15, 16, 17, 18, 20, 22, 23, 24, 25, 28, 29, 30 & 31	4, 8, 9, 10, 11, 12 & 21	5, 6 & 7

A very great magnetic storm suddenly commenced at 4 h. 59 m. G.M.T., and ended at 23½ h. on the 5th July 1941. A moderate storm occurred at 4 h. 10 m. G.M.T. on the 21st ending at 0 h. on the following day. There was one moderate storm in the corresponding month of the previous year. The mean character figure for July 1941 was 1·27 as against 0·71 in the same month of the previous year.

ASTRONOMICAL NOTES

Planets during October 1941.—Both Mercury and Venus are in the evening sky; the former will be at greatest elongation from the Sun—25° 42′ E—on October 3, but it will be difficult to see the planet on account of its low altitude at sunset. On October 27, it will be in inferior conjunction with the Sun and will afterwards become a morning star. Venus continues to be a prominent object visible for over a couple of hours in the western sky in the early part of the night. Mars will be in opposition to the Sun on October 10, and can be seen all night. It is closest to Earth on October 3, when its distance is about thirty-eight million miles and the apparent diameter of its disc 23 seconds of arc. Its apparent magnitude is −2·4, *i.e.*, it will appear about twice as bright as Sirius, the brightest star in the heavens.

Jupiter rises about three hours after sunset and is a conspicuous object in the sky for the rest of the night. It is at one of the stationary points of the geocentric orbit on October 10, when it begins to move westwards among the stars. Saturn is in Taurus and continues its slow westward motion. It rises nearly two hours after sunset; the brightness is increasing the stellar magnitude being zero at the end of the month. Uranus will be found close by, in Taurus, about three degrees to the northeast of Saturn.

The well-known meteoric showers — the Orionids are due to appear in the latter half of the month, the approximate date of maximum display being October 22. The position of the radiant is given by R.A. 96°, Declination 15° North and the meteors of this group are characterized by swift streaks. T. P. B.

SEISMOLOGICAL NOTES

During the month of August 1941, 2 moderate and a slight earthquake shocks were recorded by the Colaba Seismographs as against 1 great, 3 moderate and 1 slight shocks recorded during the same month in 1940. Details for August 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.	Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
August 1941—		H. M.	(Miles)		(Miles)	
1	Slight	09 18	1330	Near Lat. 34°·5 N., and Long. 86° E. in Tibet		
4	Slight	16 23	5780			
10	Moderate	03 48	1510	Near Lat. 10° N., and Long. 94° E. to the south of the Andamans in the Bay of Bengal		
15	Moderate	11 39	6350			
19	Slight	21 49	1710	Near Lat. 7° N., and Long. 96° E. to the east of the Nicobar Islands		
30	Slight	15 06	4810			
30	Slight	18 37	4690			
30	Slight	22 15	1430	Near Lat. 14°·5 N., and Long. 94° E. in the neighbourhood of the North Andamans		

ANNOUNCEMENTS

The tenth annual convention of the Sugar Technologists' Association of India will be held at the Imperial Institute of Sugar Technology, Agricultural Gardens, Cawnpore, on November 1–2.

Biological Abstracts.—Doctor Robert S. Morison, Department of Anatomy, Harward Medical School, succeeds Doctor Alexander Forbes as Editor of the *Neurophysiology* section in "*Biological Abstracts*". Dr. Ralph G. Smith, University of Michigan Medical School, is taking Dr. Erwin E. Nelson's place as Editor of the *Pharmacology* section *in "Biological Abstracts"*.

* * *

We acknowledge with thanks, receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, No. 4588.
"Journal of Agricultural Research," Vol. 62, Nos. 4–9.
"Agricultural Gazette of New South Wales," Vol. 52, Pt. 7.
"Annals of Biochemistry and Experimental Medicine," Vol. 1, No. 2.
"Biochemical Journal," Vol. 35, No. 3.
"Contributions from Boyce Thompson Institute," Vol. 12, No. 1.
"Journal of Chemical Physics," Vol. 9, Nos. 6–7.
"Journal of the Indian Chemical Society," Vol. 18, No. 5.
"Chemical Products and Chemical News," Vol. 4, Nos. 7 and 8.
"Experiment Station Record," Vol. 84, No. 6.
"Indian Forester," Vol. 67, No. 9.
"Transactions of the Faraday Society," Vol. 37, Pt. 5.
"Review of Applied Mycology," Vol. 20, Pt. 5.
"The Indian Medical Gazette," Vol. 76, No. 8.
"The Bulletin of the American Meteorological Society," Vol. 22, No. 5.
"Journal of the Bombay Natural History Society," Vol. 42, No. 3.
"Journal of Nutrition," Vol. 21, No. 6; Vol. 22, No. 1.
"American Museum of Natural History (Journal)," Vol. 48, No. 1.
"Nature," Vol. 147, No. 3735.
"The Philippine Journal of Science," Vol. 74, No. 4.
"Indian Journal of Physics," Vol. 24, Pt. 2.
"Journal of Research," National Bureau of Standards, Vol. 26, Nos. 5–6.

Books

"The Identification of Molecular Spectra," by R. W. B. Pearse and A. G. Gaydon. (Messrs. Chapman & Hall, London), 1941. Pp. vii + 221. Price 42*sh.*
"Practical Solution of Torsional Vibration Problems," Vol. II, by W. Ker Wilson. (Messrs. Chapman & Hall, London), 1941, Pp. xxii + 694. Price 42*sh.*
"A Text-book of Intermediate Physics in Tamil," Vol. I, by R. K. Viswanathan and V. N. Ramaswamy. (Annamalai University), 1941. Pp. lxxi + 686.
"Differential Equations," by G. S. Diwan and D. S. Agashe. 1941. Pp. ix + 316.
"Annual Review of Biochemistry," edited by James Murray Luck. (Annual Reviews Inc., Stanford University, P.O. Calif.), 1941. Pp. 1 + 691. Price $5·00.
"Annual Review of Biochemical & Allied Research in India," Vol. XI for 1940. (Society of Biological Chemists, India), 1941. Pp. 173. Price Rs. 3 or 6*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

August 1941. SECTION A.—P. BHASKARA RAMA MURTI AND T. R. SESHADRI: *A study of the chemical components of* Decalepis Hamiltonii (Makali Veru). *Part IV. Rasinols of* Decalepis Hamiltonii *and* Hemidesmus indicus. R. D. DESAI AND C. K. MAVANI: *Heterocyclic compounds. Part XIV. Coumarins from 4-ethyl-2-acetylresorcinol and β-ketonic esters.* K. NEELAKANTAM, P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Colouring matter of the flowers of* Hibiscus cannabinus: *Constitution of cannabiscetin.* KANTILAL C. PANDYA AND MISS RASHMI BALA PANDYA: *The condensation of aldehydes with malonic acid. Part XIII. The condensation of* o-, m-, *and* p-*chloro-benzaldehydes and of* m-*bromo-benzaldehyde: The influence of groups* and comparison with Perkin's reaction. N. V. SUBBA RAO AND J. VEERABHADRA RAO: *A note on glabrin, a new component of the seeds of* Pongamia glabra. S. RAJAGOPALAN: *Synthetical experiments in the group of sympathomimetics. Part III.* MOHAMMAD SHABBAR: *Einstein spaces admitting the lorentz group.* M. A. WALI, A. K. KHALIL, R. L. BHATIA AND S. S. AHMAD: *Studies in the Friedel-Crafts reaction. Part V. The effect of polar substituents on the reactivity of para-substituted phenyl succinic anhydrides with simple aromatic hydrocarbons.* D. R. KULKARNI AND N. M. SHAH: *The reduction of* $-CH(OH)CCl_2$ *group attached to a benzo-α-pyrone nucleus.* SIKHIBHUSHAN DUTT: *Pyronine dye-stuffs derived from succinic acid.* P. KAILASAM: *On the cyanogen halides.* M. R. BHIMASENA RAO AND K. S. GURURAJA DOSS: *Spreading coefficients of nekal BX solutions.* Small quantities of nekal BX greatly improve the spreading qualities of oils on polar surfaces. The spreading coefficients of nekal BX solutions are found to be negative even at the highest concentrations tried. R. NORRIS: *A study of the Raman effect in seventeen optical glasses.* The continua that follow the exciting

line in the spectra are shown to be due to a genuine Raman effect and not a case of fluorescence. V. V. NARLIKAR: *The gravitational equations of motion in relativity.* N. S. SUBBA RAO: *The effect of sunset on atmospherics.* It is pointed out that (1) the effect of sunset on atmospherics is that of trigger action, (2) the study of atmospherics can give advance information regarding the preparation of the atmosphere for the onset of a powerful thunderstorm, and (3) prolonged atmospheric activity on the short waves appears to be connected with the formation of meteorological depressions.

SECTION B.—PROF. COL. I. FROILANO DE MELLO: *Revision of the family* Devescovinidæ, *its genera and species, with record of the Indian species of* Devescovina. G. N. RANGASWAMI AYYANGAR AND K. KUNHI KRISHNAN NAMBIAR: *Studies in* Dolichos lablab (*Roxb.*) *and* (L.), *the Indian field and garden bean—IV.* G. N. RANGASWAMI AYYANGAR AND N. KRISHNASWAMI: *Studies on the histology and colouration of the pericarp of the sorghum grain.* S. B. KAUSIK: *Development of the vermiform appendage in* Grevillea robusta *Gunn.* R. K. SAKSENA: *Thiamin and growth of some species of* Pythium. K. RANGASWAMY: *Cytomorphological* studies in Asteracantha longifolia *Nees.* (Hygrophila spinosa *T. And.*). V. PURI: *Studies in floral anatomy. Part I. Gynœceum constitution in the cruciferæ.* S. HIRIYANNAIYA: *A study of the vital capacity of Mysoreans.*

Indian Association for the Cultivation of Science: (*Proceedings*)

April 1941.—A. K. DAS: *The motion of gases in the Sun's atmosphere. Part III.—On the stratification of the Solar Envelope.* M. G. SASTRY: *Structure of the electronic bands of the OD molecule, Part II.* B. N. SINHA: *Magnetic Susceptibility of two-dimensional free electron gas.* K. C. KAR: *On nuclear scattering.* B. L. MATHUR: *Circumzenithal arc tangential to a corona of* 46°. BIBHA MAZUMDAR: *On the radial limitation of the solar magnetic field.* D. M. BOSE: *The use of photographic plates as an aid to cosmic ray investigations.*

Indian Chemical Society: (*Journal*)

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Royal Asiatic Society of Bengal:

September 1, 1941.—S. L. HORA: *Races and varieties of Himalayan Mahseer:* Mahseer or the Large-scaled Barbel of India is the most famous Game Fish of the country and several books have been written on its sporting qualities. Though anglers have long been familiar with the fact that several races and varieties of this fish exist in Indian waters, the scientists, following the lead of Day, have hitherto grouped them into a single species, *Barbus tor* (Hamilton). Attempt has recently been made to study very critically the material of this species in the collection of the Zoological Survey of India with the result that at least four kinds can now be recognised from the Himalayan waters on definite morphological characters.

Meteorological Office Colloquium, Poona:

August 12, 1941.—C. G. PENDSE: *Gravity and the rotation of the earth.*

August 19, 1941.—K. NAGABHUSHANA RAO: *Saturation temperatures.*

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SCIENTIFIC TERMINOLOGY IN INDIAN LANGUAGES

A QUESTION of capital significance to the cause of science in India is that of a standard terminology in Indian languages for scientific and technical ideas and objects. With the growth of the movement for the adoption of our various provincial vernaculars as the media of instruction in schools and even in colleges in the several Provinces, the importance of the question has naturally increased; and some provincial Governments have given evidence of their appreciation of the fact. In June last year, the Government of Madras appointed a committee to consider (1) to what extent the equivalents of foreign technical terms already in use in the South Indian languages are acceptable for educational purposes; (2) whether it is desirable to retain for school purposes the use of English technical terms where there are no accepted equivalents in the South Indian languages; and (3) whether, in the alternative, it is necessary to draw up new and standardised lists of equivalents of certain foreign technical terms for all the South Indian languages.

The Committee was composed of fifteen members all of whom are scholars and educationists of high standing, some representing High School experience and others College experience. The Rt. Hon'ble V. S. SRINIVASA SASTRI was its chairman. After considering the various suggestions placed before it, the Committee formulated its recommendations and submitted them to the Government in September last year. The Government of Madras has "accepted the recommendations" and has appointed (or is about to appoint) a special committee for each of the South Indian languages as

suggested by the Sastri Committee. The principal recommendations of the Sastri Committee may be summarized as follows:—

1. (*a*) The equivalents of foreign technical terms which are already in use in accepted educational publications may continue to be used; and (*b*) other expressions current in popular usage (pertaining to ordinary concrete objects or natural phenomena like mule or metal, thunder or earthquake) may be adopted for school use. Under this head each South Indian language may have its own vocabulary.

2. For names of conceptual or abstract objects or ideas (like those of physics or physiology, mathematics or philosophy), a list common to all South Indian languages should be drawn up; and in the coining of such new words the bases may be adopted from Sanskrit for Dravidian languages, and from Persian and Arabic for Urdu.

3. Words not falling within the above two groups,—that is, non-Indian technical words which neither have vernacular equivalents already current, nor are amenable to the treatment suggested under the second head,—should be taken as they are from English and suitably transliterated for the Tamil or Telugu or Kannada or Malayalam reader.

It should be noted that the task set to the Committee was the modest one of helping education in schools, and not the rather ambitious one of providing for advanced study and independent research in science through the medium of Tamil or Kannada or Telugu. For the limited purpose which the Committee had in view, its recommendations should ordinarily have been accepted as appropriate and sufficient. But the case of South India has now been made to look out of the ordinary by the insistence of some Tamil revivalists on linguistic purism. They are opposed to the Sastri Committee's suggestion in favour of Sanskrit as a radical for the coining of new words. The Committee has taken care to point out that the group of words thus to be coined "will necessarily be small"; but even in that meagre proportion of the scientific vocabulary of the Tamilian, the Tamil purists are not prepared to have the help of Sanskrit. It is unfortunate in the extreme that unanimity should thus have been rendered unattainable in this country even in a field of life so far apart from politics.

To insist on unmixed Dravidism in current Tamil or current Kannada is not unlike the movement of some years ago to establish the reign of Saxonism in current English. What the author of *King's English* says about that movement is apposite to our purpose:—

"The Saxonist (*i*) forms new derivatives from English words to displace established words of similar meaning, but Latin descent; (*ii*) revives obsolete or archaic English words for the same purpose; (*iii*) allows the genealogy of words to decide for him which is the better of two synonyms ... The wisdom of this nationalism in language—at least in so thoroughly composite a language as English—is very questionable; we may well doubt whether it benefits the language; and that it does not benefit the style of the individual ..... is pretty clear ..... The truth is perhaps that conscious deliberate Saxonism is folly, that the choice or rejection of particular words should depend not on their descent, but on considerations of expressiveness, intelligibility, brevity, euphony or ease of handling."—FOWLER, *Modern English Usage*.

The subject is surely one that should be viewed from a higher standpoint than that of linguistic purism and of provincialism of every kind. The first consideration to be borne in mind is that of facilitating the spread of the knowledge of science in the country, whichever the linguistic medium employed. It should, by every means within our reach, be made easy for the school student, and

for the man in the street too, to acquire knowledge—clear and accurate knowledge—of the thought and the achievements of science in its various manifestations; and then, incidentally and without prejudice to the first named object, all-Indian uniformity and approximation to international phraseology should be attempted, even this second consideration being meant to help the first.

It is also necessary to make a special note of another point, namely, the peculiar requirements of terminology in science as distinguished from terminology in arts or those aspects of arts that do not lend themselves to scientific treatment. The operations of science are objective, that is, accessible to measurement and verification by means and methods that can be reported and reproduced. On the other hand, the province of artistic activity is subjective and private, belonging to a realm where every man has his own separate yard-wand and his own independent criteria of judgment not necessarily shared by others. The scientist looks outside for verification and corroboration. To the artist, his own inner testimony is supreme. The varieties of literary artifice available to a poet or a novelist to communicate the nebulous and the twilightish charms of the picture that his mind sees,—the graphic epithet, the rhetorical synonym, the vivid periphrasis,—these may not be permitted to a scientist in the statement of his theory or observation. What is of value to the artist in a word is its suggestiveness, its *vyangya,* that which lies *implicit* in the word. What is of value to the scientist, on the other hand, is its expressiveness, its *vachya,* that which is made *explicit* by it. The scientist's terms should therefore be exact in their denotation, each term standing for one definite thing and no more than one. It is hardly necessary to add that this remark applies not only to the various natural and social sciences, but also to the scientific aspects of even arts like music or literature, indeed, to all which human intelligence hopes to analyse and relate as cause and effect.

The conditions, then, which a vocabulary for science should satisfy may be set down generally as follows:—

(1) *Intelligibility.*—This includes the qualities of simplicity, directness, brevity, lucidity and also forcefulness. It should be possible for the average man to comprehend the meaning of the word without much etymological or philolcgical learning. This would mean that the words should, as far as possible, be those in current use or readily recognizable as related to words in current use.

(2) *Accuracy.*—The words should, as pointed out above, have definite and fixed meanings and should not be interchangeable. The weakness of a goodly percentage of words in Indian languages is in their inexactness and their liability to varieties of construction and in their potency to cause confusion. Great, therefore, is the need for care in selecting the bases from the word-stock of an Indian language for the forming of a new phrase.

(3) *Harmony.*—This is the fitness of the word to its context in both sound and sense. It is not rarely that the dictionary is seen to furnish more words than one to denote a single object or idea; but a good writer will not pick up any one word from that list indifferently for his sentence, but will rather choose one particular word out of those several as peculiarly suited to convey his meaning in his verbal framework. Just as we judge of a man's sociability by observing his behaviour in company, we are able to evaluate the peculiar merit of a word when we try it in a given juxtaposition. Each language has its own peculiarities of word-structure and syntax, as well as of sound-value and rhythm; and any new word we coin or borrow must be appropriate to the idicm and to the euphony of our language.

(4) *Extensiveness of currency.*—The words should be as far as possible such as can facilitate (*i*) not only the acquisition of knowledge by the student individually and at a particular stage of his education, but also (*ii*) his discussing about it and sharing it with his fellow-students and even communicating it to others, on as large a scale as possible, and further (*iii*) his using that knowledge as the basis for his higher education outside his Province and outside India.

It is in the very nature of the thing impossible to lay down any hard and fast rules as to the method of providing the needed vocabulary. The method to be adopted must necessarily depend upon the nature of the word we want, the intricacy or the abstruseness of its content, the duties it will have to perform and so forth. The principles above indicated, will have to be applied both separately and jointly in each single case. None of the four tests can be dispensed with: simplicity, precision, euphony and wide currency. If these principles are approved, the following conclusions would seem to be inevitable:

(1) The books now in use on science subjects in the various Indian languages (including school-books, glossaries and dictionaries) should be examined carefully, and expressions already well established in usage in any language should be approved as a permanent part of the vocabulary of that language. Similar recognition should be extended to words and phrases found to be common in popular speech, provided of course there is no objection on the score of grammar or good taste. Indeed, when the man in the street habitually employs a foreign term (like court, inspector, motor, bicycle) in preference to a possible Sanskritic or other Indian equivalent, one may in a majority of cases conclude that the foreign phrase has a superior claim either in its ease of enunciation or its brevity or its precision or its compendiousness.

(2) Where the ideas or the objects are altogether new and are therefore without established equivalents in Indian languages, words based on Sanskrit roots should be coined, such coinings being of course subject to the tests of simplicity, definiteness and euphony. Sanskrit has three advantages to offer which no other Indian language has: (*i*) it has its own age-old stores of scientific terms in its books on astronomy, mathematics, law, music, medicine and metaphysics. These ancient mintages are a source which it would be suicidal for India not to utilize, of course subject to the tests mentioned. (*ii*) The wealth or its sematic potential, particularly in its *dhatu* or verbal rudiments, can be manipulated to varieties of purposes by means of varieties of prefixes and suffixes (*pratyayas*). (*iii*) It is easily accepted and understood throughout India and this can satisfy the fourth canon noted above. It was surely a most wholesome instinct, and no lack of patriotism, that made the great Sri Vaishnava thinkers and sages of old adopt the style of mixed Tamil and Sanskrit called *mani-pravala* (diamond and coral) for the outpourings of their hearts and souls.

(3) Even with the most skilled and the most assiduous effort at word-coining, a great many words of science must remain inconvertible into single equivalent words in any Indian language. The growth of science, and therefore that of the vocabulary of science, has been taking place at so rapid a rate that it must be beyond the hope of even the most daring and energetic of any vernacular lexicographer in India to keep pace with it. This very prolificness of the growth, as well as the intricacy and abstruseness, of the words of science in its modern developments makes it imperative that we should be prepared to import large quantities of them *en bloc* into our languages from English, transliterating them after suitably modifying their pronounciation and even their spelling to the extent necessitated by the peculiar accent and sound quality of our language. It does not seriously matter if the Bengali or the Mahratti or the Tamil alphabet cannot find symbols for the sound of "*z*" or "*x*" or "*f*" or "*a*" or "*æ*". The nearest Sanskritic or Dravidian letter may well be asked to deputize. Recognizability is all we need look for. It should not be forgotten that the terms contemplated under this third head are mostly those of advanced science, the pursuit of which in any case would be impossible without proficiency in English or some other foreign language.

We must also remember that it will not be enough if we have succeeded in minting one single equivalent for one term in a group of correlated terms. We should then pause to see how the shining output of our mint will serve as a basis for further derivatives and how it would behave amidst its cognates and correlatives; for the possibility of the growth of such correlatives and derivatives in science vocabulary in English seems, to judge from experience, to be practically without limit.

Let us look at the history of English, the nearest among the world's languages to the ideal of a universal tongue and the language, at the same time, of perhaps the most successful people as yet in history. Says Dr. J. H. Jagger:—

"Although the structure of modern English is quite different from the structure of Latin, any one who looked at the vocabulary only might well consider English to be a descendant of Latin, for the Latin importations actually outnumber the native stock ..... While Latin has given a larger number of words to the English vocabulary than any other foreign tongue, and while French has sent us more than any other during the last century, at the present moment, ancient Greek easily heads the list of our contributors. For the great developments in industry, science and speculative thought that have occurred in modern times, the Teutonic stock in English is unfitted; and the springs of Latin were beginning to dry up when the nineteenth century dawned. In these circumstances we turned to a quarry we had already opened in Ancient Greek. From it we have since drawn large supplies of material, most of which we have used for manufacturing words that would have been a source of wonder to the Greeks. The connotation of such a word as *thermometer* they would easily have understood, but to imagine the actual instrument would have been quite beyond their power. English, of course, was perfectly able to provide us with the compound *heat-measurer*, which is self-explanatory, but would have been unsuitable because it lacks precision. It might cover other objects, while the word *thermometer* can be restricted to a single type of apparatus."

And here is the finding of an authority regarding the contribution of Greek to English:—

"The register presents a selective list of about 130,000 words. It does not purport to present *all* the English words hitherto derived or constructed from Greek. Botany, medicine, etc., swell the total to *upward of a million* words. And even if all these were recorded, the rate of new coinage must soon render any list incomplete."

There have been humanitarian thinkers since ancient times who have insisted on our regarding our whole race as but one family and suggested various measures for our realizing that ideal in tangible fact. One such suggestion has been that of an international language to supplement or complement the national or the regional. Dr. J. H. Jagger writes:—

"One of the greatest needs of the world at the present day is a universal speech ..... Physical unity has been achieved, but the universal consciousness that should be its parallel has not been achieved, because of the obstacles created by differences of speech. Not a universal consciousness only; a universal conscience also. Since nations speaking different tongues are with respect to each other in a position analogous to that occupied by individuals who cannot comprehend each other, until mankind has attained a universal speech, it will not be able to frame the universal ideals that will enable it to press forward as a single whole towards a freer, wider life of the spirit."

If this larger hope should ever come to be fulfilled, it is essential that every country under the sun should agree to cultivate a common international tongue as auxiliary to its own national tongue. The task here is not one of abolishing nationalism or obliterating patriotism, but one of demarcating moral jurisdictions and apportioning

loyalties. There is no necessary conflict among them. When soberly viewed, they appear rather as mutually justificatory. This distribution and adjustment of our linguistic loyalties is only a necessary counterpart to the marking out of the spheres of our citizenship as municipal, national and international. To the citizen of India, the claims presented for adjustment are three,—the provincial, the national and the international. The adoption of Sanskrit and English, in the main, for the second and third purposes respectively will go far towards lightening the burden of word-lore for him. One detail which the linguistic fanatic is apt to forget is that the content of a word is of greater consequence than the word itself, that language is merely the means, and that there are strict limits to the demands that can be made upon the average man's time and energy and enthusiasm by etymology and grammar, all-important though they be to the philological Pandit.

The last War taught, or in any case was supposed to have taught, the world that "nationalism is not enough". More recent events have been teaching us that nationalism, exclusive and absolute, is in fact impossible. Science itself has brought about this commingling of the lives of the nations; and particularly at the present crisis in our civilization, the larger the area of common usage and first-hand intercourse between country and country, the greater the security for international fellow-feeling and the larger the chance of equity and balance in the standards of wealth and welfare among the various peoples. When such is the consideration that should be supreme in every field of human activity, a rigid adherence to particularism and provincialism as regards the medium of knowledge and culture would be nothing but a pitiful process of stunting our own intellectual and moral growth. Science, as it has gone on drawing the several parts of the globe nearer to one another, has also gone on developing a vocabulary of its own which must be regarded as international. A bigoted and self-sufficient nationalism has been the tragic folly of several countries in the past. Just as there are spheres and levels of life, appropriate to nationalism, we must recognize that there are other spheres appropriate only to internationalism. The commerce of culture, the diffusion of knowledge and the pursuit of science which is search for the laws of the workshop of Nature and the truths of life—these belong to the higher levels; and Indians would be anticipating that better future for which the world is longing, and setting an example to others, in being all-Indian and international in their policy as regards the compilation of their scientific vocabulary.

When so much has been said in favour of India's adopting English for its scientific vocabulary in the higher grades, it seems necessary to say a word to prevent any misunderstanding of our attitude as one of insufficient appreciation of the importance of developing Indian languages. The importance of these languages is undoubted; and they cannot afford to forego the contribution which the development of a scientific literature can make to their growth. But the question at the moment is—of the two extremely desirable objects we have before us, namely, diffusion of the knowledge of science and development of the local language, which do we want more urgently?

It is impossible that both can be secured equally well at one and the same time. To us it seems, firstly, that the knowledge of science and of modern world-conditions is more urgently needed, and, secondly, that the development of vocabulary is bound to be a matter of slow growth in any case. It will, we think, be no advantage to the country to hold up the progress of education in science by the reason or unreason of our linguistic difficulties. There are a great many good things in this world all equally to be desired. But it would only make for waste of time and effort if we tried to snatch all of them at once by one single grasp of the hand. We have to postpone some in order that we may be sure of getting hold of the others.

It must also be recognised that it is given to no language to do equally well in all departments of service. Some excel in some and others in others. If Italy excelled in music, England was ready to borrow musical phraseology from there. If France was eminent in the culinary art, England was similarly prompt again. There are fields of life and achievement in which it has been given to Indian languages to attain high success. In the realms of the mind and the spirit, in poetry and philosophy, Sanskrit has made a record which is the envy and the admiration of other languages. The remembrance of the distinctiveness of the gifts and merits of the various languages of the world should be an influence for moderation on our linguistic patriotisms. If each separate language had not had an ethos of its own and a separate "mission" of its own, there would be no justification for the world's allowing so many languages to live and thrive. Diversity has its uses, like unity; and it profits nobody to bewail that any one's single language cannot do *all* things or have *all* things desirable. The greater destiny of the Indian languages is before them—yet to come as the crown of their present enrichment and growth.

The problem, as we have said, is not one confined in its significance to any one region or province, but relates to the whole of India. It therefore needs to be taken up by an all-India agency. His Excellency LORD LINLITHGOW will have rendered a service of first-class importance to India if he would move his Government to set up a special all-India committee to consider this matter in all its bearings and, in consultation with the Inter-University Board, the All-India Educational Conference, the Indian Science Congress and similar other bodies, to formulate proposals for the compilation of Scientific and Technical vocabularies in two grades, one for each important linguistic area and limited to the simpler and more easy objects and ideas, and the other for the whole of India and extending to complex and difficult items of scientific knowledge and thought. The urgency of the matter must be obvious to every one who has appreciated how far behind Europe and America and Japan this country is in respect of the power which science has made available to man.

D. V. G.

THE SEVERE MAGNETIC STORM OF SEPTEMBER 18, 1941

BY

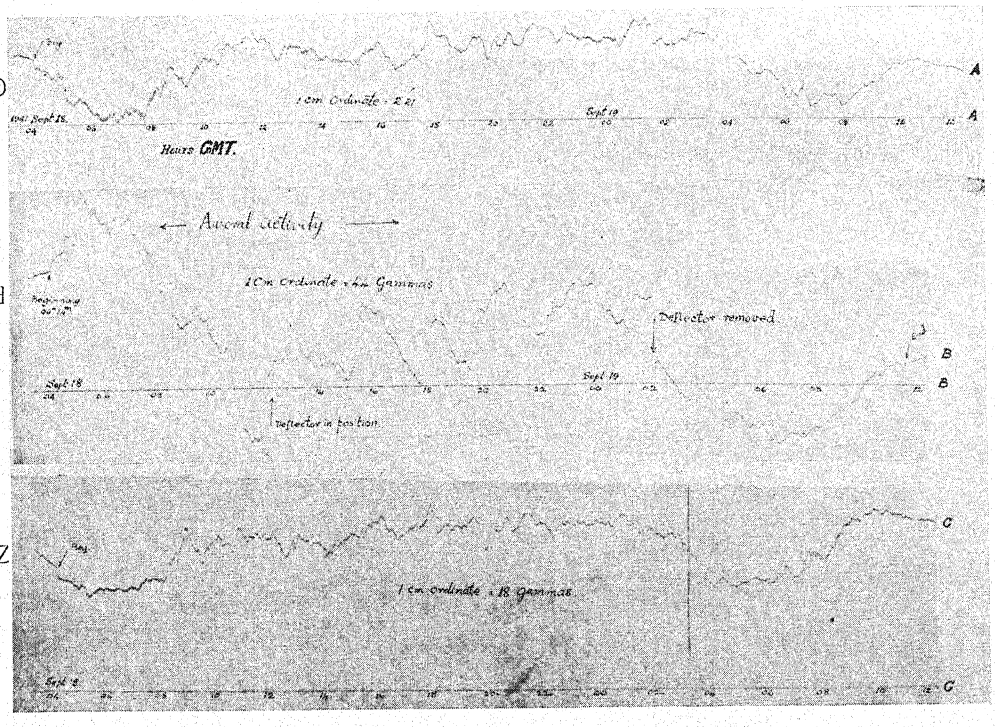
M. R. RANGASWAMI AND A. S. CHAUBAL

(*Alibag Magnetic Observatory, Bombay*)

AT 4h 14m G.M.T. (corresponding to 9h 44m Indian Standard Time) on Thursday, the 18th September 1941, the magnetographs at the Alibag Magnetic Observatory recorded the commencement of a severe magnetic storm which upset wireless and telegraph traffic all over the world. According to Reuter's reports, there was a display of Aurora Borealis for two nights in succession from the 18th September 1941 and the lights which were very brilliant were seen from many parts of Britain particularly in East Anglia. The Indian Telegraph Department experienced considerable disturbances on their circuits and made very frequent telegraphic enquiries from the Alibag observatory which promptly gave the details regarding the progress of the storm. In India, receptions of the broadcasts of the B.B.C. and other foreign stations were also affected.

The storm can be considered to be the severest of its kind during the current year. The two other storms of importance during the year were those of 1st March 1941 and 5th July 1941. Both these storms were of severe intensity and caused moderate dislocation to the telegraph traffic. A detailed description of one of these storms, *viz.*, that of March 1, 1941, which was the intenser of the two, has been given in a note by one of us in an earlier issue of that Journal.

The magnetograms of the few days prior to the day of the storm do not indicate any special activity. The days 14th to 17th September 1941 were slightly disturbed being of international character No. 1. On the 17th, the day previous to the storm however, the Solar Physics Observatory at Kodaikanal observed a large sun-spot group crossing the central meridian. This spot



Severe Magnetic Storm of 18th September 1941. (D. H. & Z. Magnetograms recorded at the Alibag Observatory.)

activity may perhaps be associated with the severe storm of the 18th September.

Characteristics of the storm of September 18, 1941.—The beginning of the present storm of September 18, 1941, was marked by a sudden rise of 26 gammas in horizontal force *H*, and of 1·3 minutes in Westerly declination *D* and a fall of 9 gammas in the vertical force *Z*. *H* rose gradually till $4^h\ 48^m$ G.M.T. and after this the magnet became quite unsteady with low-period oscillations of varying amplitudes. At $5^h\ 7^m$, *H* shot up rapidly by 141 gammas in barely fourteen minutes. At about $5^h\ 22^m$, the maximum value in *H* occurred but the position of the light speck was just beyond the recording limit of the photographic paper. The value of *H* at this time was more than 470 gammas above the baseline value. The vertical force attained its minimum value at about the same time. Westerly *D* attained its maximum value at $7^h\ 10^m$. A gradual fall in *H* associated with rapid vibrations commenced at $5^h\ 26^m$ and continued till $10^h\ 36^m$ when a large decrease of 224 gammas occurred in 52 minutes. At this time the value of *H* oscillated about this value for about 20 minutes and showed a tendency to fall rapidly from $11^h\ 50^m$ onwards. The value of *H* rapidly decreased and as there was the risk of the light speck going off the recording limit of the photogram, a deflecting magnet was used at $12^h\ 6^m$ and the trace was shifted upwards by 169 gammas. Rapid fluctuations in *H* were continuing till $15^h\ 20^m$ when there was a sudden rise of 144 gammas in about twenty minutes. From $15^h\ 44^m$ *H* began to fall again to attain its minimum at $17^h\ 50^m$. Both the vertical force and westerly *D* attained their maxima a few minutes after *H* reached its minimum value. Immediately after attaining the minimum *H* rose by 149 gammas in twenty-four minutes and thereafter rose and fell at stages with ups and downs such as have been noticed in terrestrial magnetic records associated with Auroral activity. As the need for a deflector magnet disappeared, it was removed from its position at $2^h\ 16^m$ on the 19th, resulting in the curve being shifted downwards by 158 gammas. The *H*, *D* and *Z* magnetics continued unsteady till $6^h\ 44^m$ on the 19th September, after which *H* began to rise very gradually with minor fluctuations. The range in horizontal force during the storm exceeded 650 gammas, while the ranges of *D* and *Z* were 12·0 minutes and 87 gammas respectively. The storm practically ended at $11{\cdot}5^h$ on the 19th although *H* continued low for a couple of days.

The magnetograms of the day of the storm as recorded at the Alibag Observatory have been reproduced in the figure.

WHISTLING METEORS. A DOPPLER EFFECT PRODUCED BY METEORS ENTERING THE IONOSPHERE

THE Research Department of All-India Radio has recently concluded an investigation of an effect hitherto unobserved. It is reported that the flight of meteors through the upper atmosphere, which results in clouds of ionized gases following the meteors at their tremendously high velocities of several kilometres per second, gives rise under certain conditions to peculiar types of low frequency whistles on the unmodulated carrier waves from nearby shortwave transmitters. The production of these whistles is explained on the basis of interference between the ground wave and a weak sky wave which has undergone a slight change in its frequency due to 'Doppler Effect', *i.e.*, due to reflection from the head of the rapidly moving ionized cloud caused by the passage of a meteor. This conclusion which is supported by observations and experiments is likely to be of far-reaching importance in the realm of astronomy. A detailed account of the investigation appears elsewhere.

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WHY GRAVITATION?

No gravitational theory has so far been able to explain gravitation, that is, why masses attract and do not repel. m/r satisfies Laplace's equation, m being a constant, positive or negative and r having the usual meaning. So also the static solution of Einstein's field equations, *viz.*,

$$ds^2 = -dr^2(1-2m/r)^{-1} - r^2(d\theta^2+\sin^2\theta d\theta^2) + c^2(1-2m/r)dt^2 \quad (1)$$

introduces m as a constant of integration which may be positive as well as negative. The question is whether we can deduce from first principles that

$$m > 0 \quad (2)$$

under all circumstances. It is, no doubt, a question of considerable historical interest and it has acquired some additional interest because of the recent discovery that protons at nuclear distances *attract* each other.

Lanczos[1] has recently published a theory to justify (2) in (1). He gives arguments for assuming

$$R_{ij}\, g^{ij} \equiv R = 0 \quad (3)$$

in a particle, R being the linear scalar invariant of the contracted Riemann-Christoffel tensor. The condition (3) makes m of the second order of smallness and positive. This procedure is unsatisfactory on account of the introduction of a new assumption (3) and also because of the new numerical relation that follows between inertial and gravitational masses. Although Lanczos[2] has found arguments in support of the numerical relation the consequences of (3) appear to weaken the case for that assumption.

A simple consideration may be presented how (2) is implicit in (1) on account of the relativity hypothesis that no observable velocity can exceed the velocity of light in ether, c. The apparent velocity of light in a field of force can be different from c. In electromagnetic[3] fields we know why the apparent velocity of light is less than c. In a radial direction the velocity of light in the gravitational field of a particle is

$$v_r = c(1-2m/r)$$

while, in a transverse direction, the velocity is

$$v_t = c\,(1-2m/r)^{\frac{1}{2}}.$$

If the observed values of v_r and v_t are not to exceed c it is necessary that (2) be satisfied. It is thus clear that the observed property of gravitation or attraction of particles in deducible, within the framework of general relativity, from the hypothesis that an observable velocity cannot exceed c. For a deeper understanding of the phenomenon we may have to await a

synthesis of quantum principles and general relativity.

V. V. NARLIKAR.

Benares Hindu University,
August 25, 1941.

[1] *Phys. Rev.*, 1941, **59**, 708.
[2] *Ibid.*, 1941, **59**, 805.
[3] Frenkel, J., *Wave Machanics (Elementary Theory)*, 1936, **7**.

THE STATIONARY CATHODE SPOT OF A LOW PRESSURE MERCURY ARC DISCHARGE

THE cathode spot of a mercury arc at low pressure wanders about rapidly and irregularly over the surface of the mercury pool. It has been found possible, however, to anchor this spot on a metal part, partly dipped in the pool.[1] We have studied some characteristics of the low pressure mercury arc with an anchored cathode spot.

The mercury arc was struck in a spherical pyrex glass bulb with a cylindrical iron anode and a mercury pool which served as the cathode. A nickel rod, slightly projected over the surface of mercury, was fixed at the bottom of the bulb. It is observed that on striking the arc the cathode spot races round and round over the pool, but after a time attaches itself to the nickel rod and becomes stationary. With the increase in the arc current the spot grows larger in size and encircles greater portion of the rod till it completely surrounds it. If the spot is detached from the rod, it starts dancing over the mercury surface again as the arc current exceeds a critical value and now the rod is as much favoured by it as any other point on the pool. A linear relation is found to exist between the critical current and the diameter of the rod. The current at which the spot completely surrounds the rod is always found to be a fraction of the critical current and for all currents below this critical value the spot remains permanently stationary at the common boundary of nickel and mercury. Moreover, the critical current is found to be independent of the distance between the cathode and the anode.

It is also observed that the cathode spot can be split up into two parts by using two nickel wires partly dipped in mercury. The two wires are kept in contact with each other at the time of starting the arc and the current is gradually increased till the cathode spot surrounds both the wires. The spot gets divided into two components if the wires are now separated. This division of the spot does not take place, however, if the wires are kept apart before the arc is on. In that case the two wires behave independently and the critical current for either is not influenced by the presence of the other. On the other hand, when the spot is split into two components, the arc current can be safely increased to a value equal to the algebraic sum of the critical currents of the two wires. With further increase of current the spots leave the wires and recombine into one which starts racing over the mercury pool as before.

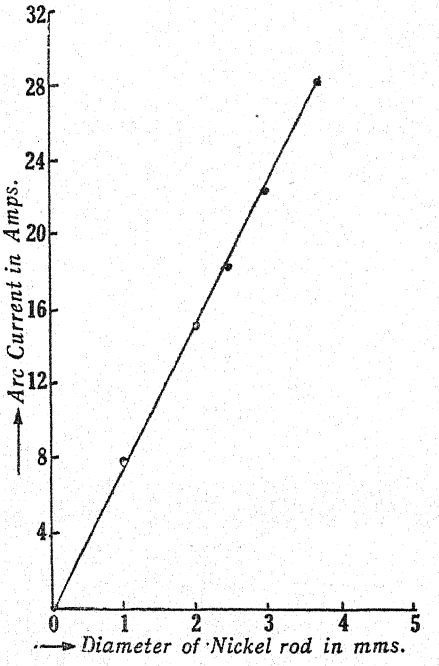

FIG. 1

Fig. 1 shows the linear relation between the

critical arc current and the diameter of the nickel rod partly immersed in mercury.

The details of the experiment will be published elsewhere.

RAFI MOHAMMED CHAUDHRI.
ABDUL QADIR KHAN.

Department of Physics,
Muslim University, Aligarh,
August 9, 1941.

[1] N. Warmoltz, *Physica*, 1940, **7**, 209.

MIXED SOLVENTS FOR SOAPS

IT is a peculiar fact that alkali metal soaps of palmitic acid, stearic acid, etc., are only sparingly soluble in most organic solvents and so far no good organic solvents for them have been discovered though a large amount of study is being made in connection with the relationship of soaps with organic solvents.[1] This fact has precluded a study of various aspects of soap solutions in organic solvents, which would have been highly useful since soap stands unique as being an organophilic compound of well-known chemical structure. It has however been found out in this laboratory that suitable mixtures of organic solvents have powerful dissolving action on the alkali metal soaps, though the individual components are practically non-solvents for the same.

Detailed studies of such enhanced solvency are under progress and the results will be published elsewhere. It has been observed that any mixture of a monohydric alcohol and a polyhydric alcohol has a powerful solvent action on soaps, though they are individually practically non-solvents at ordinary temperature. There is an optimum solvent composition, where the solubility is maximum and this happens for ethylene glycol ethyl alcohol mixture at about 65 : 45 composition by weight for sodium stearate.

For the same glycol, it appears that the higher the molecular weight of the alcohol, the more is the solvent power, which has been found out by experiments with aliphatic alcohols upto amyl alcohols. For the same alcohol, of the five polyhydric alcohols tested, the efficiency is in the order shown in Table I. By combining suitable mixtures of these latent solvents in appropriate proportions, more than ten per cent. concentrations can be produced at room temperature, and practically any concentration from a thin fluid to transparent gels at temperatures higher than 40° C.

Hydrocarbons have been found to have a peculiar coupler action on these solvent mixtures. Though they are neither themselves solvents for soap, nor have they any perceptible latent solvent activity in combination with any of these aforementioned solvents, in combination with A-G mixtures (alcohol-glycol mixtures), they bring into play a profound solvent action even at room temperature or lower. Suitable A-G-H mixtures (alcohol-glycol-hydrocarbon) have been found, which rapidly dissolve soap at room temperature to almost any concentration not even tending to saturation till production of transparent gel. All the four types of hydrocarbons (aliphatic, cycloparaffins, benzenoid and terpenic) have been found to possess this coupler action to a more or less degree. The following table lists the 'latent solvents' and 'couplers' so far investigated in order of their solvent power. Naturally a week solvent power can be counteracted by using powerful complimentary latent solvents and couplers. For example, glycerol may be turned into a powerful solvent for soap in mixture with iso-butyl alcohol coupled by small quantities of benzene.

TABLE I

Latent Solvents		Couplers
Monohydric Alcohols	Polyhydric Alcohols	Hydrocarbons
iso—Butyl alcohol	Ethylene glycol	Benzene
iso—Amyl alcohol	Propylene glycol	Turpentine
n—Propyl alcohol	Di-ethylene glycol	Cyclohexane
Ethyl alcohol	Glycerol	Heptane
Methyl alcohol	Trimethylene glycol	Hexane

Gels are very easily produced by cooling any such strong solution of a soap in A-G or A-G-H mixture below saturation temperature. These gels are elastic, and transparent to translucent depending on the nature of the solvent mixture, and they show reversible sol-gel transformation, perhaps like other soap gels in organic solvents.[2] It will certainly be of interest to study such transparent soap gels from the standpoint of synerisis, solvation, swelling, etc.

These solutions offer interesting study about their molecular nature, particularly since it is known that though aqueous solutions of soaps are colloidal electrolytes, alcoholic solutions are non-colloidal and of very weak electrolytic nature.[3] So far preliminary experiments on electrical conductivity and ultrafiltration show that these solutions are perhaps truly molecular. The question whether such molecular solutions form gel on increase of concentration or lowering of temperature through reversible association to form micelles, or if such elastic gels are really single-phasic molecular systems, is only to be decided by later experiments, in which the observation recorded herein will certainly be helpful as offering an easy way of producing such solutions and gels of a well-known group of chemical individuals over a wide range of concentration and temperature.

S. R. PALIT.

Indian Lac Research Institute,
Namkum, Ranchi,
September 11, 1941.

[1] Vold, Legett and McBain, *J. Phys. Chem.*, 1940, **44**, 1058; Ledrer's *Kolloid chemie der seife*, 1932; other references in these publications.

[2] Banerji and Ghosh, *Zeits. Anorg. u. Allgem. Chem.*, 1930, **194**, 304.

[3] Krafft, *Ber.*, 1899, **32**, 1584; Laing McBain, *J. Chem. Soc.*, 1918, **113**, 435.

A NOTE ON THE PRODUCTION OF COLOURING MATTERS FROM CERTAIN INDIAN LICHENS

MANY species of lichens have been employed from the earliest times for the production of dyestuffs such as archil or orchil which contain the colouring matter known as orcein and directly applied in dyeing brown and buff colours on animal fibres such as wool and silk. Among these the species of Roccella and Lecanora have ranked among the foremost. By a modification of the process adopted for the preparation of orchil, the colouring matters contained in the commercial litmus are also obtained.

The lichen, *Roccella montagnei*, which occurs abundantly in Waltair, has been thoroughly investigated in these laboratories and found to have varying combinations of its constituents in different samples, as indicated below:[1]

(*i*) Erythrin and erythritol besides small quantities of free orcinol.

(*ii*) Lecanoric acid, erythritol and roccellic acid besides small quantities of free orcinol.

(*iii*) Montagnetol, orcinol, erythritol and roccellic acid.

(*iv*) Erythrin, montagnetol, orcinol, erythritol and roccellic acid.

It has now been found that the newly discovered compound, montagnetol, is a derivative of orcinol and the lichen thus appeared to be a promising source of orcinol, being rich in orcinol compounds (*viz.*, erythrin, lecanoric acid and montagnetol). Though several species of the genus *Parmelia* have been examined by chemists none of them seems to be included in the category of 'true orchils'. During the course of an examination of the lichen *Parmelia abessinica*, which occurs abundantly in the Bellary and Cuddapah districts of South India, it was found that the lichen contains lecanoric acid 3·3 per cent. and atranorin 1·1 per cent. besides small quantities of other compounds, the high lecanoric acid content indicating an equally high content of orcinol.

It was therefore considered desirable to investigate the utility of the above two lichens for the preparation of the colouring matters. Using the well-known standard methods, with slight alterations in the experimental technique, samples of orchil and azolitmin have been prepared from both the lichens. Detailed tests carried out indicated that the purified samples

of azolitmin obtained from the two sources were as sensitive and useful as an indicator as a pure sample of azolitmin (Merck). An estimation of the orcinol content of the two lichens by the Reymann method gave the following values:

Roccella montagnei	3·4 per cent.
Parmelia abessinica	3·1 per cent.

In view of the fact that these lichens occur so abundantly and the orcinol content of each is high, there appears to be a large scope for utilising them in the production of orcinol.

The authors wish to express their thanks to Prof. T. R. Seshadri for his kind interest in this piece of work.

V. V. KUMARA SASTRY.
V. SUBBA RAO.

Department of Chemistry,
Andhra University, Waltair,
August 26, 1941.

[1] Rao and Seshadri, *Proc. Ind. Acad. Sci.*, 1940, **12 A**, 466; 1941, **14**, 199.

COLORIMETRIC ESTIMATION OF PHOSPHORUS IN SOILS

RECENTLY in connection with some work on soils, where a large number of soils had to be examined periodically for phosphorus content, the need for a rapid and accurate method necessitated the re-examination of the colorimetric methods.

Several workers have used stannous chloride, hydroquinone, 1 : 2 : 4 amino-naphthol sulphonic acid, in the colorimetric estimation of phosphorus in soils. It was observed by various investigators, that silica and iron interfered in the normal colour development and modifications and improvements were suggested from time to time. Warren and Pugh[1] have given certain suggestions to eliminate the interference by organic matter and iron, but these have been found difficult and tedious and reliable and reproducible results could not be obtained by other workers.[2,3]

A simple procedure which gives accurate and quick results with a variety of Indian soils has been developed; the method is described below.

10 gm. of soil are digested with 1 : 1 HCl : HNO_3 mixture for about 6 hours at 100° C. with frequent shaking. As a condenser a funnel containing a glass bead in the neck is placed over the flask. The whole of the extract is filtered, washed, and made up to volume (250 c.c.). 10 c.c. aliquot in a test tube (220 mm. × 11 mm.) is treated with 1 to 2 gms. or more of sodium bisulphite and boiled vigorously until the solution becomes colourless and water clear. The solution is then cooled, diluted to 50 c.c. after transference with washing into a 100 c.c. volumetric flask or stoppered cylinder. It is then treated with NH_4OH until a haziness (white) develops which settles to a dirty white coagulum on standing. At this point it is immediately neutralised with a few drops of H_2SO_4 (20%). 10 c.c. of ammonium molybdate in 5N H_2SO_4[4] are then added immediately followed by 5 c.c. of 1 : 2 : 4 amino-napthol sulphonic acid reagent (0·25 gms. dissolved in 100 c.c. of 15% $NaHSO_3$ and a few drops of 20% Na_2SO_3). The contents of the flask are then mixed and made up to 100 c.c. 15 minutes allowed for full development of colour and solution compared against a standard.

For citric acid extracts we suggest the following procedure. Suitable aliquots (100–250 c.c.) are concentrated to a syrup in a 250 c.c. kjeldahl flask, treated with 1–2 c.c. of H_2SO_4 (conc.) followed soon after by 2 to 3 c.c. of HNO_3 (conc.) to oxidise the organic matter. Digestion of the organic material is over in about 5 minutes. A further five minutes are allowed for removal of nitrate fumes. After cooling, 10 c.c. of water are added and the flask again heated to boiling; this removes the last traces of nitric fumes. Filter, wash and make up to 50 c.c. Take aliquots and proceed as described above.

During the course of our work it was found that upto 5,000 p.p.m. of Fe''' had no effect on

the colour developed. Full details will be published elsewhere.

N. G. C. Iengar.
Sharif Warisi.
Sirajuddin Sadiq Bhai.

Phipps Laboratory for
Agricultural Chemistry,
Imperial Agricultural Research
Institute, New Delhi,
September 27, 1941.

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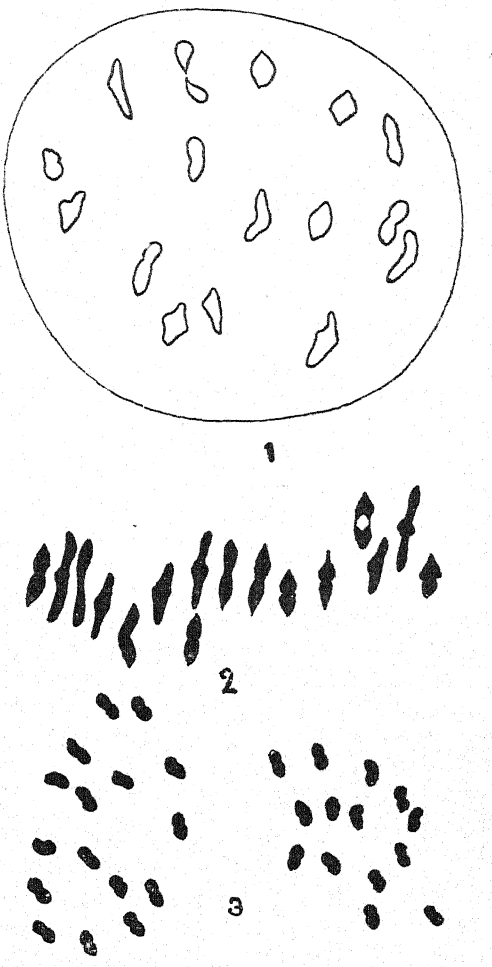
[1] Warren and Pugh, *J. Agric. Sci.*, 1930, **20**, 532.
[2] Ian Armstrong Black, *Soil Sci.*, April 1941.
[3] D. K. Patel, "Thesis Associateship I. A. R. I.," Private communication.
[4] Fiske and Subbarow, *J. Biol. Chem.*, 1925, **66**, 375.

CHROMOSOME NUMBER OF *SESAMUM PROSTRATUM* RETZ.

The genus *Sesamum* which includes our cultivated *til*, *S. orientale* L. (= *S. indicum* L.) is also represented in India by two wild species, *viz.*, S. *laciniatum* Klein and *S. prostratum*. While the chromosome number of the cultivated species has been reported by several authors[1,2,4] as $n = 13$, that of the wild species has not so far been recorded. This note records the chromosome number of *S. prostratum*.

Seeds of this species were obtained through the courtesy of Rao Bahadur G. N. Rangaswami Ayyangar, Millets Specialist, Coimbatore, and plants raised at the Imperial Agricultural Research Institute, New Delhi. The plants are prostrate with trailing branches, thick orbicular leaves, purple flowers and black seeds; they are remarkably free from the attack of diseases and pests to which the cultivated species is generally susceptible. Pollen meiosis in these plants was studied in acetocarmine smears. Figs. 1, 2 and 3 represent late diakinesis, metaphase I and metaphase II respectively which clearly show that the gametic chromosome number of the species is 16.



In a recent note John and Narasinga Rao[3] reported the somatic chromosome number of an Argentine species, *S. radiatum* Schum. and Thonn. as 64. It is interesting to notice that the Indian wild species, *S. prostratum* with $2n = 32$ chromosomes bring out the existence of a polyploid series in the genus. Although it is not possible, with the data regarding chromosome numbers at present available, to postulate a basic number for the genus, it is obvious that *S. orientale* with $2n = 26$ does not fit into the scale of polyploidy as revealed by the chromosome numbers of the wild Indian and Argentine species. The origin of the cultivated species with the 'heteroploid' number of chromosomes and the possible utility

of the wild species for breeding superior forms of *til* are under investigation.

S. RAMANUJAM.

Section of Economic Botany,
Imperial Agricultural Research Institute,
New Delhi,
October 2, 1941.

[1] Morinaga, T., Fukushima, E., Kano, T., Maruyama, Y., and Yamasaki, Y., *Bot. Mag., Tokyo*, 1929, **43**, 512.

[2] Nohara, S., *Jour. Coll. Agri. Tokyo, Imp. Univ.*, 1934, **13**, 9.

[3] John, C. M., and Narasinga Rao, U., *Curr. Sci.*, 1941, **10**, 364.

[4] Richaria, R. H., and Persai, D. P., *Ibid.*, 1940, **9**, 542.

TRICOTYLEDONY IN *MORUS MULTICAULIS* PERR.

TRICOTYLEDONY is a phenomenon, sometimes reported in some genera of the dicotyledonous angiosperms.

Buonocore[1] first reported tricotyledonous seedlings in *M. alba* and stated that it was not possible to determine which external character or hereditary (genetical) character was responsible for its appearance.

The present writer found one tricotyledonous seedling of the variety *Roso* of *Morus multicaulis* in a seed-bed this year.

The normal pair of cotyledons are of equal size, opposite to each other and measure 11 mm. in length each. They are borne on the hypocotyl and have prominent veins. The third cotyledon originates from a point a little higher and a little smaller (4 mm. in length) (Fig. 1).

Due to the rarity of these specimens it is proposed to search for more materials the next season, when the true interpretation of such a phenomenon will be discussed in a subsequent paper in the light of various theories put forward by competent authorities.

In conclusion, the writer wishes to convey his sincere thanks to Mr. S. C. Mitter, Director of Industries, and Mr. C. C. Ghosh, Deputy Director of Sericulture, Bengal, for their encouragement and to Dr. S. P. Agharkar, Head of the Department of Botany, Calcutta University, for his helpful suggestions and criticisms.

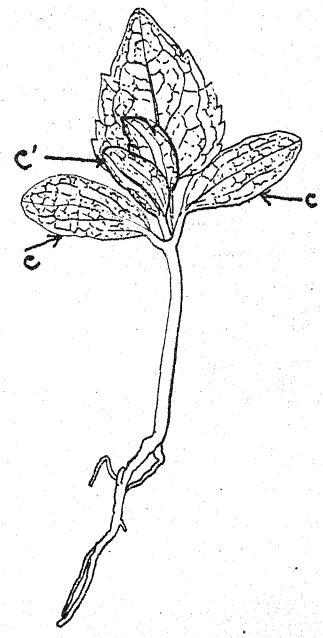


FIG. 1

Tricotyledonous seedling of *Morus multicaulis* var. *Roso*. C. denotes the normal pair of cotyledons. C', denotes the third cotyledon. × 4.

R. M. DATTA.

Sericultural Research Station,
Narayanpur Colony, Dum Dum,
August 12, 1941.

[1] Buonocore, C., Fenomeni teratologici in *Morus alba* L. Anomalie dell' apparato sessuale, *Boll. d, R. Staz. di Gelsicolt e Bachicolt di Ascoli, Piceno*, 1933, **17**, n. 3-4 17-18.

THE GAS-BLADDER OF THE GOBIOID FISH *BOLEOPHTHALMUS BODDARTI* (PALLAS)*

IN dealing with the modifications of swim-bladder in certain air-breathing fishes of India, Hora[1] stated that "*Periophthalmodon, Periophthalmus* and *Boleophthalmus* are almost terrestrial in their habits and possess well-developed cheek pouches for the storage of air.

* Published with the permission of the Additional Revenue Secretary (Rural Reconstruction), H. E. H. the Nizam's Government, Hyderabad (Dn.).

The air-bladder is absent in these genera." It is, however, very interesting to note that though the habits and habitats of *Boleophthalmus boddarti* (Pallas) are more or less similar to those of *Periophthalmus*, a small gas-bladder in *Boleophthalmus* is associated with its more pronounced terrestrial mode of life.

The gas-bladder in *B. boddarti* is a small, ovoid or ellipsoidal structure, lying freely in the body cavity of the fish above the alimentary canal, and is supported by the mesentery (Text-fig. 1). It has no pneumatic duct, *i.e.*, it is of a physoclistous type.

A star-shaped gas-gland with five retia mirabilia is present on the anterior end of the gas-bladder (Text-fig. 2), very much resembling that of *Peristethus catapharactus* (*Peristedion cataphractum* C.V.), one of the Triglidæ, described by Woodland, the only difference

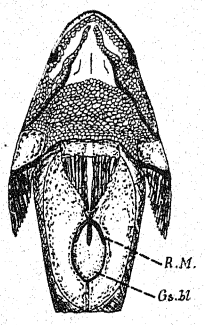


FIG. 1

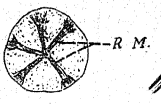


FIG. 2

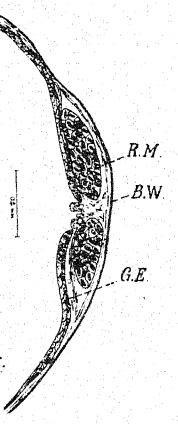


FIG. 3

Showing the position of the gas-bladder (Gs. bl.) and retia mirabilia (R. M.) *in situ* in *Boleophthalmus boddarti* (Pall.). ×⅔. Anterior portion of the gas-bladder, showing the disposition of the retia mirabilia (R. M.). × 1⅓. Camera lucida drawing of a transverse section passing through the anterior portion of the gas-bladder (Gs. bl.), showing two retia mirabilia (R. M.) cut across, the bladder-epithelium (B. W.) and the gas-gland epithelium (G. E.).

being that the retia mirabilia in *Peristethus* are ten in number. The 'red-body' in *Boleophthalmus* is star-shaped, owing to the fact that the artery and vein supplying the glandular epithelium, when arriving at the centre of the star-shaped 'red-body' break up each into five vessels. Each rete mirabile supplies a portion of the glandular epithelium.

The histology of the gas-gland of this fish is very interesting and presents the following characteristic features:

(1) The epithelium of the gas-gland is not folded and is only one to two-cell thick and encloses erythrocytes (Text-fig. 3, G.E.).

(2) The bladder-epithelium (B.W.) is usually one-cell thick and no erythrocytes are found in it.

(3) Taking a small portion of the anterior region of the gas-bladder wall it is seen that usually two retia mirabilia (R.M.) are cut across in a transverse section, each of which is divided up into innumerable minute, extremely thin-walled compartments, or, in other words, really consist of a bunch of extremely fine blood-capillaries, the lumen of each of which contains one or two erythrocytes.

I wish to express my great indebtedness to Prof. S. G. Manavala Ramanujam for all the help and facilities he gave me while I was working on this fish in his laboratory at Madras. I am very thankful to Dr. S. L. Hora for the correct name of this fish. My thanks are also due to Prof. B. K. Das for some useful suggestions.

M. RAHIMULLAH.
Department of Fisheries,
H.E.H. the Nizam's Government,
Hyderabad (Deccan),
September 17, 1941.

[1] *Curr. Sci.*, 1935, **3**, 336.

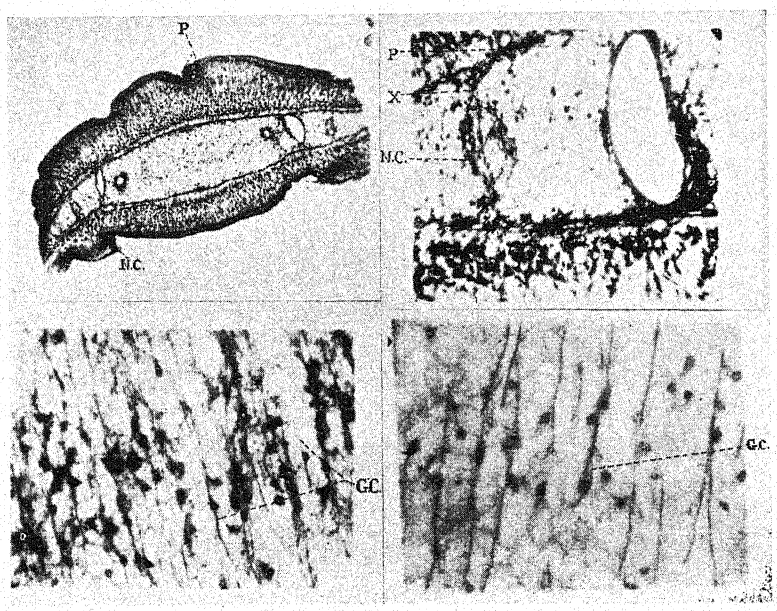
SYMPATHETIC INNERVATION OF PROGLOTTIDES IN *AVITELLINA LAHOREA* WOODLAND

IN a recent paper[1] I raised the question as to how a proglottid is able to live and move after having become detached from the proglottid chain? Rietchel[2] from a study of the physiology of successive co-ordinated contraction waves in *Catenotœnia* comes to the conclusion that the stimulus producing contractions

is not dependent on the brain since it can arise in any proglottid. His interpretation is that the wave is myogenic and is transmitted mechanically in a backward direction through the tension of the contracting muscle fibres.

It is a well-known fact that in Tetraphyllids ripening of germ cells takes place after the proglottides have become free. Is there any nervous mechanism in such proglottides co-ordinating the activities of the various organs? A plexus has been observed in proglottides by Blochmann,[3] Zernecke[4] and myself.[1,5] In vertebrates there is a dense plexus of nerve fibrils in different tissues of the body (Boeke[6]) which plays a fundamental rôle in the maintenance of metabolism. Some interesting results have been obtained with the Bielchowsky technique in *Avitellina lahorea* Woodland which seem to suggest that the plexus in the proglottides is comparable to the sympathetic plexus of vertebrates.

The material was very refractory and after about 150 experiments some very good impregnations were obtained. But even in these slides the muscle fibres are black. A similar blackening of muscle fibres in *Ligula* after chrome silver method is recorded by Blochmann.[3] In lightly impregnated slides showing typical sense cells, the muscles are yellow, but they go black when toned with gold chloride. To get a clear idea of the arrangement of the nerves and nerve fibrils we have to turn to cross-sections. Photomicrograph 1 is a transverse section of an immature proglottid. Outside the excretory vessels are the two nerve cords running the length of the proglottid chain. In all Taenia, according to Cohn,[7] there should be ten nerves running throughout the chain of segments. In *Avitellina* immature and mature segments show only two longitudinal cords. In Flemming and Zenker fixed material, the transverse sections of the longitudinal cords show nuclei on their external border. Often these nuclei completely encircle the cord.



1 2 3 4

1. Transverse section showing the two nerve cords, the two plexuses and the ganglion cells in the medullary parenchyma. Bielchowsky. × 15.

2. Transverse section showing bundle of nerve fibrils from the nerve cord running into the plexus. Bielchowsky. × 102–5.

3. Ganglion cells in the medullary parenchyma. Bielchowsky. × 147–5.

4. Ganglion cells. Cajal. × 175.

G. C.–Nerve cells, N. C.–Nerve cord; P. Plexus X.–Bundle; of nerve fibres from the nerve cord entering the plexus.

But even in such instances a semi-lunar area on the outer margin appears studded with nuclei. Bielchowsky preparations present an entirely different appearance (Photo 3). What strikes one in a transverse section is the scattered ganglion cells in the medullary parenchyma as recorded previously for *Ligula* by Zernecke[4] (Photos 3 and 4). Some are bipolar and others multipolar. The cell is dark in well-impregnated Bielchowsky preparations, and the nucleus could not be differentiated from the cytoplasm. In material treated with 2% silver nitrate, without previous fixation, the nuclei of these ganglion cells are very clear and show a nucleolus (Photo 4). The cell bodies and fibrils in such cells are only lightly impregnated. In Flemming and Zenker sections carefully stained in iron hæmatoxylin the nuclei of the neurones could easily be differentiated from others.

Just below the bundles of longitudinal muscles on the dorsal and ventral sides is a plexus of nerve fibrils having the shape of a low arch (Photo 1). The fibrils from the ganglion cells in the medulla either end on this or often cross it to end on the cuticle. Bipolar and multipolar nerve cells are found in this plexus. Usually in these plexuses there is a concentration of ganglion cells in the centre which sometimes juts into the medulla as a knob (Photo 1).

The most interesting observation is that the main nerve cords do not send nerve branches to any of the organs. It is true that nerve fibrils could be seen leaving the nerve cord in various directions but such fibrils are few in number and neither do they go to all the organs. At irregular intervals bundles of fibrils leave the main cords, enter and get mingled with the fibrils of the plexus (Photo 2). The innervation of the various regions of the proglottid seems to be by nerve fibrils from the plexuses. These could be traced to muscle bundles and bundles of fibrils could be seen passing between the longitudinal muscles towards the cuticle.

From the above description it will be seen that the various organs in the proglottid are mainly innervated by fibrils from the plexus and from the ganglion cells lying free in the medulla. It appears also that the function of the main nerve cords is only co-ordination of the activities of the various proglottides. Therefore it is easy to understand how on detachment from the chain a proglottid is able to live independently. One is reminded in this connection of the well-known experiments of Cannon and co-workers.[8] Cats, whose right and left sympathetic trunks were removed surgically lived in good health when suitably cared for. Though disconnected from the central nervous system the sympathetic plexuses were capable of maintaining the normal working of the organs.

Are we seeing in cestodes a separation of the function into central and sympathetic of the original diffuse network of jellyfishes and other Cœlenterates?

M. K. SUBRAMANIAM.

Department of Zoology,
University of Madras,
September 22, 1941.

[1] Subramaniam, M. K., *Rec. Ind. Mus.*, Sept. 1941 (In press).

[2] Rietschel, P. E., *Zool. Anz.*, 1935, **111**, (3/4), 109.

[3] Blochmann von F., *Biol. Zentralbl.*, 1895, **15**, 14.

[4] Zernecke, E., *Zool. Zahrb. Anat.*, 1896, **9**, 91.

[5] Subramaniam, M. K., *Curr. Sci.*, 1940, **9**, 500.

[6] Boeke, J., *Problems of Nervous Anatomy*, Oxford Univ. Press, London, 1940.

[7] Cohn, L , *Zool. Jahrb. Anat.*, 1900, **12**, 89.

[8] Cannon, Newton, Bright, Menkin and Moore, *Amer. J. Physiol.*, 1929, **89**, 84.

A NEW SPECIES OF THE NEMATODE GENUS *BLATTOPHILA* COBB, 1920 FROM A COCKROACH

THE author got an opportunity to dissect several specimens of *Supella supellectillum* Serv. One of them was found to be infected with a single specimen of a nematode. On examination the worm was found to resemble closely *Blattophila sphaerolaima* Cobb, 1920. But the differences between the two appear to be sufficient enough to regard it as a new species of the genus *Blattophila* Cobb, 1920. The name *Blattophila supellaima* is proposed for it.

GENUS BLATTOPHILA COBB, 1920.

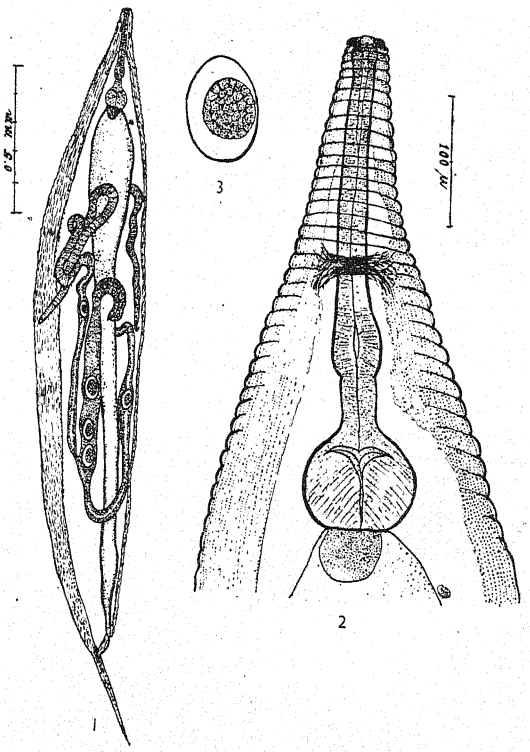
Generic diagnosis.—Thelastomatinæ: "Oral opening surrounded by eight labiopapillæ, amphids represented externally by small round openings at level of labiopapillæ. Lateral alæ absent. Buccal cavity short and wide, partially surrounded by anterior end of œsophagus and having at base six cuticular thickenings serving as points of attachment for muscles. Œsophagus consists of (1) a clavate corpus distinctly enlarged at anterior end in form of a sub-spherical swelling, and (1*a*) a posterior part slightly swollen but not set off, (2) a short narrow isthmus, and (3) a bulb. Excretory pore posterior to base of œsophagus. Intestine dilated at anterior end; cæcum absent. Tail of male truncate, conical, bearing two large pre-anal submedian papillæ adjoining anus, and two similar post-anal papillæ, one-third of a body diameter, posterior to anus. Spicule represented by a rudimentary point. Tail of female filiform and spine-like. Vulva anterior to middle of body. Eggs ellipsoidal."

BLATTOPHILA SUPELLAIMA, sp. nov. (Figs. 1 to 3)

Specific description.—Blattophila:

Male unknown.

Female: 2·5 mm. long by 360 μ wide. Cuticle annulated; annules about 10 μ wide near the head and 15 to 20 μ wide at the mid-region of body. Buccal cavity short and wide, partially surrounded by the anterior end of œsophagus, 10 μ deep by 12 μ wide. Œsophagus 387 μ long, cephalic swelling of œsophagus 15 μ long by 20 μ wide, corpus 262 μ long with a minimum diameter of 17 μ and a maximum diameter of 40 μ which represents the posterior swelling; isthmus 40 μ long by 27 μ wide; bulb 85 μ long by 90 μ wide. Nerve ring 175 μ from the anterior end of body. Excretory pore posterior to base of œsophagus, 455 μ from the anterior end of body. Intestine thick-walled with a distinct dilated cardia. Anus 380 μ from posterior end of body. Tail filiform. Vulva 1·02 mm. from anterior end of body, about 41 per cent. of the body length from the anterior end. Ovaries two, both anterior, directed posteriorly and reflexed anteriorly. Vagina directed anteriorly, true vagina cuticularly lined, about 100 μ long, communicating with the single uterus which runs straight backwards to a length of about 700 μ where it meets the two oviducts, one of which is directed anteriorly, the other is directed posteriorly for about



Blattophila supellaima sp. nov.

FIG. 1.—Adult female, latero-ventral view.
2.—Female, œsophageal region.
3.—Egg.

100 μ, then becomes reflexed and runs anteriorly parallel to the first oviduct. Both the oviducts meet the ovaries at about one-third of the body length from the anterior end. The ovaries get reflexed at about 270 μ posterior to base of œsophagus, and become directed posteriorly. They originate somewhere near the region of the vulva. Eggs ellipsoidal, 80 μ long by 60 μ wide.

Host.—Supella supellectillum Serv.

Location.—Intestine (rectum).

Type locality.—Aligarh (North India).

Type specimen.—Museum of the Zoological Laboratories, Muslim University, Aligarh; Helminthological collection No. 1023.

The Genus *Blattophila* Cobb was, up to this time, represented only by a single species,

Blattophila sphærolaima Cobb. Chitwood (1934) has described a nematode from *Panesthia javanica* which closely agrees with the description given by Cobb for *Blattophila sphærolaima*; but because of the very few differences between the two, Chitwood did not think himself justified to create a new species for his worm. He has described it as representing a new variety of Cobb's species. The worm described in this paper differs from both of them in the following characters: (*a*) The vulva is relatively much farther posterior than in both the previously described specimens (41 per cent. of the body length from the anterior end of body as against 28 per cent. in Cobb's specimens and 21 to 23·6 per cent. in Chitwood's specimens); (*b*) the vagina is directed anteriorly as against that of Cobb's and Chitwood's species where it is described as directed posteriorly; (*c*) the tail is comparatively much smaller in length (15·2 per cent. of the body length as against 23·6 per cent. in Chitwood's specimens). The writer considers these differences sufficient enough for the erection of a new species.

M. A. Basir.

Department of Zoology,
Muslim University, Aligarh,
September 9, 1941.

Basir, M. A., *Proc. Ind. Acad. Sci.*, 1940 (B), No. 1, 8; *Ibid.*, 1941, (B), No. 3, 163.
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Chitwood, B. G., *Zeit. Parasitenk*, 1932, **5**, 1, 14.
—, and Chitwood, M. B., *The Philippine Journal of Science*, 1934, **52**, 4, 381.
Christie, J. R., *Jour. Agr. Res.*, 1931, **42**, 463.
Hammerschmidt, K. E., *Abhanda. Wien.*, 1846–47, **1**, 279.
Travasses, L., *Int. Oswaldo Cruz. Suppl.*, 1929, **5**, 15.

AN INTERESTING CASE OF MIGRATION OF THE STONE-LICKING FISH, *GARRA MULLYA* (SYKES), FOR BREEDING

On the 23rd March 1941, while making a collection of fishes in the upper reaches of the Kallar Stream, about 4 miles above Mondieruma-thozhu bridge in the Pampadampara-Kombai bridle-path, Peerumedu Taluk, Travancore, the present writer observed shoals of *Garra mullya* (Sykes) dashing upstream over a fairly steep slippery rock where the water had spread out to a depth of hardly more than an inch. The sight was remarkable since it was a mad rush on the part of the fish, prompted by some irresistible force, to reach the pool above where there was a gentle flow of water. Enormous numbers of fish had collected together below the rock and were moving upwards in a body. At one dart they would traverse 1 to 2 feet over the rocky surface against the swift current and would attach themselves to the rocks firmly with the aid of their suckers and the paired fins, resting for a few seconds before attempting the next move. The water was hardly sufficient to cover the fish and wherever they attached themselves, the water arched over them due to the obstruction caused. One or two small depressions on the rock served as convenient resting places during the upward journey. Whenever a fish failed to effect a firm grasp by the aid of the sucker, it was carried down for a considerable distance. The fish chose the path of least resistance, as was evident from the fact that on one side of the stream, where the fall of the water was abrupt and vertical, no migratory activity was witnessed, whereas on the opposite side, where the gradient was lower, the activity was at its maximum. An estimate of the large numbers present can be made from the fact that over 40 lbs. of migrating fish, about 5 to 8 inches in length, were collected from a small side channel 10 yards long, 1 to 3 feet wide and a few inches deep by blocking it above and below.

The presence of people in close proximity did not materially disturb the fish in their migratory activities. Some of the coolies who accompanied the writer and who could hardly be dissuaded from the temptation of making as rich a harvest as possible, stationed themselves midway with sticks and knives and picked up the fish one by one as they ascended.

It is not possible to say when the activity had started and when it would have ended. It was noticed at 2 p.m. and the writer could not remain on the spot for more than 3 hours.

All this time the migration continued unceasingly. The local hill tribes, Mannans and Palikans, on being asked about this told the writer that such activities have been noticed by them, but they were not in a position to give any information as to the exact season and duration. This particular case observed by the writer does not seem to have any relation to rains, as no rainfall had been recorded in this area for over 2 months.

All the migrating fish were adults and they were so full of ova and milt that these streamed out profusely even when the fish were very gently handled. The females were relatively larger in size and more in number than the males. One medium-sized specimen measuring 6 inches contained 3,834 well-developed eggs. The early development is exactly like that of the Ceylon form, *Garra ceylonensis ceylonensis* (Bleeker) described by the writer in 1938.[1]

Migratory breeding activity is well known in Cyprinid fishes. As regards *Garra*, Dr. S. L. Hora informs me that a photograph of migrating fish of this genus was published in some popular journal in 1920, though he has not been able to locate it. It would be helpful if any of the readers of this note could kindly give the reference.[2] Dr. Hora has referred to the mass movement of these fishes in the *Records of the Indian Museum*, 1921, 22, 637.

Garra mullya (Sykes) is very common in the hill-streams of Travancore; it is called locally *Kallalotti*, *Kallilotti*, *Kallotti* and *Kallamutti*, referring to its habit of adhering to stones. It grows to a length of nearly 8 inches and is eaten by people resident in the hills, though not so much relished as some of the larger Cyprinids.

S. JONES.

Central Research Institute,
University of Travancore,
Trivandrum,
August 1, 1941.

[1] S. Jones, *Ceylon Journ. Sci.*, 1938, **6**, 91.

[2] Dr. Hora thinks that the photograph referred to above may have appeared in the *Times of London, Illustrated Weekly*.

AN INDIAN SOURCE FOR COLCHICINE

THE use of Colchicine for inducing polyploidy is now well known to plant-breeders. Clewer, Green and Tutin (1915) have chemically analysed the alcoholic extract from the tubers of *Gloriosa superba* L.* (N.O. Liliacea) and found that in addition to other chemical compounds, it contains the alkaloid Colchicine to the extent of 0·3% of the dry weight of the tubers, as against 0·35 to 0·4% in *Colchicum autumnale* L. *Colchicum autumnale* L. is not a native of India but has a distribution in the temperate region round-about the Mediterranean and Central Asia. The only allied species found in India is *Colchicum luteum* growing on the grassy slopes of the Western Himalaya.

The cost of the pure alkaloid is about Rs. 10 per gram and of the crude product Colchicum corn or seed powder is about Rs. 5 per lb. In view of the wide distribution in India and Ceylon of this weed *Gloriosa superba* L. and the great cost of the imported drug, it is suggested that attention may well be directed to the exploitation of this Indian weed for obtaining the valuable alkaloid.

In a preliminary experiment in these laboratories, maize seeds were treated with an extract of *Gloriosa superba* and sown. The developing roots showed tetraploid sectors—a result very similar to the effects of treatment with aqueous solution of Colchicine.

N. PARTHASARATHY.

Imperial Sugarcane Station,
Coimbatore,
October 4, 1941.

[1] Clever, H. W. B., Green, S. J., Tutin, F., *Jour. Chem. Soc. Trans.*, 1915, **107**, 835.

[2] Martindale and Westcott, *The extra Pharmacopœia*, 1932, 20th Edition.

* Vernacular names of *Gloriosa superba* L.

Hind. Karihari; *Ur.* Meheria-phulo, Agni-sikha; *Tel.* Adivi-nabhi, Kalappa-gadda, Potti-dumpa, Ganjeri; *Tam.* Kala-paik-kilangu, Kannuvelli; *Mal.* Mettonni

REVIEWS

The Birth and Death of the Sun. By George Gamow. (Macmillan and Co., Ltd., London), 1941. Pp. xiv + 232. Price 12*sh.* 6*d.* net.

Of the various problems of modern astronomy, the one concerning stellar structure is perhaps the most interesting from the point of view of the scientific minded layman. The subject itself is but of recent development. Although the problem has attracted the attention of philosophers from the earliest times, the prevalent ideas about the internal constitution and the evolution of stars were for a long time mostly speculative, and even in the beginning of the nineteenth century, it is said, Herschel imagined the sun to be a hot globe of vast dimensions with possibly a cool interior core that may be habitable. The fundamental researches of Lane, Kelvin, Ritter, Emden and Schwarzchild, to mention the names of only a few of the pioneers, laid the foundation for many of the subsequent investigations on the mechanism by which the sun's light and heat are maintained; and it is to be noted that the recent progress in nuclear physics has to a large extent, contributed to the important advances made during the last two decades.

In the present book with the attractive title "The Birth and Death of the Sun", Prof. Gamow has given a clear exposition of the present knowledge of the problem of 'Stars in action' in a manner suitable to the general reader who takes an intelligent interest in current scientific thought. The book is authoritative and written in a fascinating style; and the treatment is none too technical. Mathematical formulæ are avoided and all important results are explained in simple non-technical language. The illustrations are excellent and the diagrams —many of them drawn by the author in his inimitable style—clearly illustrate the argument and add much to the interest of the work.

The book opens with a chapter on the 'Sun and its Energy', in which, after some preliminary explanation, we have a discussion of the problem of the age of the sun, and the source of the tremendously large output of energy radiating from it. Chapters II–IV deal with a variety of topics in physics, required for an understanding of the latter parts of the book, and contain an account of such subjects as the structure of the atom, the problem of the atomic nucleus, radio activity, the transmutation of elements and the liberation of sub-atomic energy. The application of the results of these discoveries to investigations of energy generation in the sun is treated in the next chapter, where we find a description of Bethe's work on the cyclic chain of nuclear reactions. Chapter VI contains a brief survey of some of the principal facts of astrophysics —the theory of giant and dwarf stars first formulated by Russell, and the Mass-Luminosity relation discovered by Eddington. The abnormal stars—the red giants and the white dwarfs—are considered in the next two chapters and an attempt has been made to deduce the life-history of the sun—its initial and final stages by considerations of analogy with these classes of objects. It will be of interest to readers in India to note the references made to the important contributions of Chandrasekhar and Kothari to the study of the collapsed state of stellar bodies. The characteristics of novæ and supernovæ are dealt with in Chapter IX and the last three chapters contain brief discussions of a number of cosmological topics—the formation of stars and planets, the galactic system, its structure and rotation, the extra galactic nebulæ and their enormous velocities of recession. The book concludes with a short resume of the current ideas of stellar evolution in the light of the facts that have become available from recent researches.

There is an atmosphere of pleasant humour throughout the exposition which makes even the difficult parts of the book delightful reading, and, here and there short anecdotes are related which add to the interest. The book will, no doubt, have a

very important place in the popular literature on astrophysics. T. P. B.

General Bacteriology. By D. B. Swingle, (Chapman and Hall, London), 1940. Pp. xii + 313. Price 16*sh.* nett.

Many books have been published and are being published on Bacteriology. Some of them are voluminous tomes which try to present all available information, Chemistry, Biology, Genetics, etc. An informative, pleasant book which takes the beginner step by step into the field of Bacteriology without leading him straightaway into the difficulties and ignorance which besets the student when first he tries to learn the subject,—a book which can be placed safely into the hands of a nurse or a student who only learns Bacteriology as a side-show-optional subject, has not been obtainable so far; Dr. Swingle's book goes far to supply this deficiency. Perhaps the book under review is rather ambitious in bringing in chapters on Sewage, Bacteriology of Molds, etc. A Sanitary Engineering student, who has to have a working knowledge of Bacteriology can also well use the Book.

The binding and typography are excellent. Many of the pictures are of pen and ink and give quite vivid pictures of Bacteria; the danger here is that these may leave an impression (which may not be wiped out later) that bacterial structures are simple and the mind may not be open to the more intricate problems of R. and S. Strains, Capsules, Antigenic structure, etc.

The price is not too heavy for a book of this type. ENNE.

University of Calcutta "Anthropological Papers"—New Series, No. 6, 1941. Calcutta University Press.

This periodical publication was started to enable the teachers and senior students of the Department of Anthropology of the University of Calcutta to publish promptly, the results of their investigations. The present issue contains five papers on Social Anthropology, four on Physical Anthropology, and one each on Prehistoric Archæology and Primitive Technology. Prof. Chattopadhyay reviews Khasi Kinship and Social organisation in the light of his recent investigations. Mr. T. C. Das seeks to explain, in an article of great theoretical interest, some ritual rôles of relatives-in-law among the Kuki tribes of Manipur, as relics of matrilocal residence which required a man on his marriage to join the wife's household. In a short paper, Mr. N. K. Bose attempts to date the boulder-conglomerate beds at the paleolithic site at Kuliana in the Mayurbhanj State. The four papers dealing with Physical Anthropology are: (1) Studies in Eyebrows among the Bengalees; (2) Incidence of the Muscle Palmaris Longus among the Marwari Community; (3) The Pterion in Indian Human Crania; (4) Study of the Head-Hair of the Noluas of Bengal.

The long paper on Garo Law of Inheritance by Mr. J. K. Bose is a demonstration of the manner in which anthropology can, even in India, be of practical use to the administrator, as it is in other parts of the world. There is a wrong belief current among the executive and judicial authorities that Hindu law or the laws that apply to the lower castes can be applied to the primitive tribes. But this is a subject that has not been gone into in most parts of tribal India. The administrators who had the wisdom to use the anthropologists, and the anthropologists themselves are to be congratulated on this fruitful co-operation.

This number of "Anthrological Papers" is dedicated to the memory of that brilliant investigator and inspiring teacher, the late Dr. Panchanan Mitra, by his devoted friends of the Calcutta University Department of Anthropology which he did much to build up. A. AIYAPPAN.

Strontium and Phosphate Minerals. *Bulletins of Economic Minerals*—No. 3, Strontium; No. 4. Phosphates. By Dr. M. S. Krishnan. (*Records of the Geological Survey of India*, 1941.) Pp. 76. Price As. 6 and As. 12 respectively.

The Bulletins give an exhaustive account of the mineralogy, occurrence and uses of these industrially important minerals together with technological notes on the preparation, marketing and utilization of the various products obtainable from them.

The chief source for Strontium in India is noted to be from Celestite occurring in the cretaceous rocks of the Trichinopoly District, Madras, where the available quantity of this mineral is expected to be between 500,000 to 1,000,000 tons. As the mineral has been re-discovered only recently, there has been no production so far. Dr. Krishnan points out that the manufacture of Strontium salts being comparatively easy, there is no reason why these salts cannot be prepared locally from Trichinopoly celestite, and used in pyrotechnics, in the paint industry, and for making medicinal preparations. He also points out that celestite of the requisite grades can be ground and used in place of barite in paints and as filler in rubber, lac and other industries.

In the Bulletin on Phosphates, Dr. Krishnan gives a general survey of the resources of all the countries of the world producing the phosphate minerals, together with detailed notes of practical value on prospecting, mining and preparation of the minerals, and the technology of their products and their uses. The important sources available in India are from the apatite deposits of the Singhbhum District, the phosphatic nodules from the Trichinopoly District and also from a bed of phosphate rock at Mussoorie in the United Provinces. The estimated reserves from the two important areas, *viz.*, about 700,000 tons of apatite containing between 20–25% of P_2O_5 in Singhbhum and 8 million tons of nodules containing roughly some 25% of P_2O_5 from Trichinopoly indicate rather poor resources for a vast country like India whose dominant occupation is agriculture, requiring large amounts of manurial products. It is regrettable that even these available sources have not been satisfactorily developed or exploited so far. Dr. Krishnan opines that further work on the utilization of our phosphate minerals may be carried out on the lines of what has been achieved in America by the Tennesse Valley authority. He considers that the Flotation process could probably be used to obtain the requisite concentrated grade from the available raw material and also that the Calcination process has distinctly good possibilities. The fused and the calcined phosphates are low-cost products which have a high manurial value and can well compete with the imported phosphatic manures and therefore, their manufacture locally is well worth consideration.

Another distressing feature in India, to which Dr. Krishnan draws attention, is the export of bones and bone meal from this country which has to import the manufactured phosphatic manures. The country thereby sustains a double loss and this is a matter which ought to receive the earnest consideration of Government and industrialists alike. M. B. R.

Padakatintlo Vignanacharcha (*Bedroom discourses in Science*). By Mr. Vasanta Rao Venkata Rao, Maharaja's College, Vizianagaram, 1941. Pp. 97.

This is a booklet in Telugu treating of some modern scientific ideas in a popular manner, in homely, non-technical language. It is in the form of bedroom discourses by a man of science. The author explains some facts in Astronomy and Physics in an interesting manner, referring, wherever possible, to similar ideas expounded by our ancients. The planetary system, the starry world, the three states of matter, the constitution of the atom, wave motion, electro-magnetic radiation and the X-rays are the subjects dealt with. In an Appendix, some of the more important instruments of observation, such as the telescope, the microscope and the spectroscope are described with the help of diagrams.

Tracts like these should be published in large numbers in our vernaculars with a view to create in our people a taste for Science. B. V.

THE MANURING OF SUGARCANE IN INDIA

A CRITICAL examination and summary of the results of the large number of experiments on the manuring of sugarcane in India mainly with the object of making suitable recommendations on this important aspect of sugarcane cultivation has been carried out by R. D. Rege at the instance of the Imperial Council of Agricultural Research and this has now been published (*Misc. Bulletin No.* 41 *of the I.C.A.R.*). The experiments examined are comparatively recent ones covering the period from 1932–39, as these experiments have been laid out in conformity with the new statistical technique and are deemed more accurate and reliable than those conducted before this period which indeed are very much the more numerous. A brief summary of the results of these earlier experiments is however extracted from the "Analysis of Manurial Experiments in India," published already. A soil map of India is inserted to show the main types on which sugarcane is grown to which results of experiments conducted in the respective soil tracts may be considered more applicable. The broad classification however is between the Gangetic Alluvium tract of Upper India and the quite different type of soils and climate of peninsular India. Coming to the results themselves, farmyard manure is considered first. Applied on the basis of an equal nitrogen content, farmyard manure is inferior to oilcakes and sulphate of ammonia, whether used by themselves or in conjunction with farmyard manure. This is one definite result in the midst of a good deal of indefiniteness which prevails more or less with regard to most other aspects of manuring. Data regarding the residual effect of farmyard manure are conflicting; data regarding its rôle as a 'soil improver' (apparently its physical condition) do not relate to a sufficiently long period. Data are likewise too meagre for deciding the relative value of farmyard manure and compost, apparently both on the basis of equal nitrogen content. Regarding green manuring sannhemp has been the general crop used for this purpose, and on the whole has been found the best. It is stated that the ploughing in of the whole crop is better than ploughing in the above-ground portion alone or the below-ground portion alone, and at the same time that the utilisation of the stems for the extraction of the fibre does not affect the manurial value of the crop, which is rather difficult to understand. Molasses as a fertiliser has also given inconclusive results, being found decidedly good in Upper India and of little value in the south. Upper Indian results make it out to be a very promising material whose use may, with advantage, be encouraged. There are no results of a decisive character regarding the relative values of the different oilcakes on the yield of cane or the quality of the juice. It may however be pointed out that the rates of nitrification of most oilcakes is known and for the rest the price per unit of nitrogen at which the particular cake can be had can decide the choice. A noteworthy and somewhat surprising result is that *mahua* oilcake (the *Ippe* cake of Mysore) has been used as a good manure and that it has been found indeed better than other cakes. The cake has been found in South India to be inert as regards nitrification even for periods of more than two months in the soil and in view of the saponin content it has not been recommended at all.

Coming to the inorganic fertilisers we are told that much of the huge mass of data relate to experiments either defective in design or inadequate in replications. Reference is made to certain very accurate experiments, which indeed have brought out the same conclusions that have been reached long before and have formed almost the basic facts in sugarcane manuring. Thus, the response is certain and striking, increasing progressively only with nitrogenous manuring, the response to phosphatic and potash manuring is negligible, the latter indeed has a depressing effect. This was in the Punjab. Likewise in Patna it was found that potash was not necessary. Potash with Niciphos in fact depressed the yield. The rôle of potash and the reason for these results in a plant which is cultivated for its sugar, a constituent which potash manuring is generally believed to favour, certainly demand closer study. In Assam the potash manuring has been found distinctly beneficial, both yields and sucrose content improving as the result. Reference is made to the very high doses of nitrogen up to 200 and 250 lbs. per acre used with advantage in Mysore and the inconclusive effect of sulphate of potash. The question of organic *versus* inorganic manures is then taken up and results bringing out the need for the use of organic manures in soils which are deficient in organic matter are referred to as well as the facts that sulphate of ammonia alone is able to bring about very large yields and that such manuring reduces the purity of the juice. The need for experiments continued over a long period of several years on this aspect of sugarcane manuring is stressed. Indeed the lacunae in the information on cane manuring are very numerous and nothing is more prominently clear from this summary than the need for accurate and long continued experiments.

A. K. Y.

THE COLABA OBSERVATORY

THE latest administration report of the India Meteorological Department publishes pictures of a barometer and a raingauge, two century-old instruments in use at the Colaba Observatory.

The Colaba Observatory at Bombay was erected in 1826, its site having been earmarked for it three years earlier, under the direction of the East India Company. Mr. Curnin was the first Astronomer. But it was not until 1841 that the observatory became an active centre when on the recommendation of the Royal Society, systematic observations began and the observatory was associated in research on meteorology and magnetism and also in time signal work. Thus it is that the current year is regarded as the centenary year of the Colaba Observatory.

In 1865 a committee of enquiry, set up by Government, recommended the installation of full equipments for magnetic and meteorological work, comprising the latest type of recording instruments and the appointment of a full-time and fully qualified officer to direct the work of the observatory. These recommendations were at once acted upon and Mr. C. Chambers was appointed Superintendent in 1865. The fruitfulness of the observatory under Mr. Chambers' direction is apparent from the large number of papers published by him in scientific journals, and by the volumes issued from the observatory during the years 1865 to 1894 which contain valuable contributions to the sciences of terrestrial magnetism and meteorology.

On the death of Mr. Chambers in 1896, Dr. N. A. F. Moos succeeded him. In 1898 a seismograph was set up to take part in the programme of observations started by the seismological committee of the British Association. In 1899 the control of the observatory passed from the Government of Bombay to the Government of India.

Owing to the decision to electrify the Bombay City at the beginning of 1900 and the consequent risk of disturbing the magnetic records obtained at the observatory, it became necessary to remove the magnetic work from Colaba to a place free from artificial disturbances. A new magnetic observatory was consequently built at Alibag and the magnetic work was permanently shifted to that place in 1906. By that time Colaba had the creditable record of more than 60 years of continuous magnetic records and in 1910, Dr. Moos published a comprehensive study of the whole, for the period 1846–1905 under the title "Colaba Magnetic Data", and this has remained a mine of information for later workers in the subject.

In 1930 regular observations on atmospheric electricity and potential gradient began to be taken. Studies of the changes of electric field associated with the movement of thunder-clouds and monsoon clouds have been made. The phenomenon of "earth-currents" has been investigated. Seismological work has been considerably extended and a quarterly Seismological bulletin containing the analysed data of the seismograms of all the Indian observatories is being issued from Colaba since 1937.

The observatories at Colaba and Alibag function as a centre for geophysical research in India. Their activities are directed to obtaining regular records of the phenomena of terrestrial magnetism, meteorology, seismology and atmospheric electricity, to the reduction and discussion of recorded facts and observations and to the publication of the results obtained. Star observations are taken for the purpose of time-keeping and the rating of marine chronometers. The observatory is equipped with various magnetic, meteorological, astronomical and seismological instruments.

CENTENARIES

Mendenhall, Thomas Corwin (1841–1924)

THOMAS CORWIN MENDENHALL, an American physicist, was born on a farm in Ohio, 4 October, 1841. He was largely self-educated. After leaving school in 1861, he taught mathematics and physics in various schools and became professor at the Ohio Agricultural and Mechanical College in 1873. In 1878 he was appointed professor of physics at the Imperial University of Tokyo. In 1881 he took up a similar appointment in the Ohio State University. In 1884 he joined the scientific staff of the Federal Government and retired in 1904.

While at Tokyo he established a physical laboratory and a meteorological observatory. He also measured the absolute force of gravity at Tokyo and its relative value in relation to that at Fujiyama. From these data, he determined the mean density of the earth and his value was considered best.

He invented an improved portable apparatus for the measurement of gravity. He was the first to propose the use of the ring pendulum for measuring the absolute force of gravity.

Though not a University man, he was given many honorary degrees and medals of learned societies. He was elected president of the American Association for the Advancement of Science in 1889.

Mendenhall died at Ravenna, Ohio, 22 March, 1924.

Hunt, Charles Wallace (1841–1911)

CHARLES WALLACE HUNT, an American engineer, was born at Candor, 13 October, 1841. After receiving his early education in the local institutions and serving in the war department for a short period he purchased a small coal business in 1868.

Not satisfied with the clumsy methods used for handling coal, in 1872 he invented a system by which coal was unloaded from cars or barges by cars which rose to inclined elevated tracks over which they travelled by gravity to all parts of the storage area. The little cars dumped automatically and were returned to the barges by the energy stored in weights which were raised by the cars during the loaded runs. This system was such an immediate success that he floated a new company to develop and manufacture it.

He also so improved the storage plants that he was called upon to build many large coal terminals throughout the world. It is said that his invention reduced the cost of handling coal to one-tenth the prior cost. His methods have since been applied to other materials as well.

He then turned his attention to the manufacture of industrial railway system, in which he was the first to make the system of units which could be purchased and combined to form any desired arrangement of tracks about a factory. He also experimented on flexible rope which resulted in his paper on *Rope driving* which remained for many years the best work on the subject.

Hunt died on Staten Island, New York, 27 March, 1911.

S. R. RANGANATHAN.

University Library,
Madras.

SCIENCE NOTES AND NEWS

Studies on the British White-flies.—The recent publication by Dr. K. N. Trehan [*Trans. R. Ent. Soc.*, London, 90, (22), 575] gives useful information on the species of British *Aleurodidœ*. He gives a complete account of their morphology, habits and food-plants and discusses their systematic position and parasites. The author has given conclusive facts in proving the synonomy of some of the important species and his descriptions of the immature and adult stages of the various species throw light on their systematics and morphology. The comparative study of the various forms yielded two new species (*Proc. R. Ent. Soc.*, London, (B) 7, 182). Besides, the author has also shown that colour variations exist even in the individuals of one and the same species (*Ind. J. Ent.*, 1, 71) and that the distribution of spines on the nymphs and pupæ, can in no way be considered a satisfactory taxonomic character. Both these characters, therefore, variable as they are, have no classificatory significance and cannot be adopted.

The importance of the 'vasiform orifice' and the genitalia has been thoroughly discussed and their reliability as significant diagnostic characters has been established. These characters have yielded valuable specific differences with the result that new species and genera have been erected and cases of doubtful nature have been properly dealt with. The entire work has been supplemented by the addition of keys for identification of adult as well as pupal characters.

It is believed that the paper under reference will prove of value in the investigations on Indian white-flies which demand our early attention. It is, therefore, hoped that the Imperial Council of Agricultural Research will take up this problem and provide necessary facilities with a view to investigating in detail the systematics and bionomics of the aleurodid fauna of India and compiling the available data about them on the lines similar to those adopted for the British white-flies. Since this group as a whole, including as it does pests of cotton, sugarcane, citrus and castor, is of considerable economic importance, it is hoped that it will receive the early patronage of the Council.

K. G. BHANDARI.

Nutrition Conference, Washington, 1941.—The National Nutrition Conference for Defence, summoned by President Franklin D. Roosevelt which took place in May (26–28) at Washington provided an opportunity "to explore and define the nutrition problems and to map an immediate programme of action" (*Experiment Station Record*, 1941, **85**, 1–4). The Conference was organised in nine sections among which the following may be mentioned: Research and National Nutrition Problems; Economic Policy and Social Responsibility as Related to Nutrition; Public Health and Radical Aspects of Nutrition; Nutrition for Workers in Defense Industries; Methods of Education in Nutrition; Professional Education in Nutrition and Nutrition Problems in Distribution and Processing of Foods. The Conference as a whole expressed its belief "that poor diets and undernourishment are widespread in this country" and that "while these conditions offer no grounds for alarmist statements, they are serious enough to be a genuine cause of weakness in the present national emergency and to warrant national attention and concerted action". The Conference urged the need for "vigorous and continuous research to add to our knowledge of the nutritional needs of individuals, the nutritional status of groups in the population, the nutritive content of everyday foods, and the effects of various methods of processing, storing, and cooking on their nutritive value". Section 1, relating to Research and National Nutrition Problems, dealt with all the principal lines of inquiry in the nutrition field. Sufficient information is available for formulating adequate dietaries at several cost levels, for recognizing several specific types of malnutrition, for conserving nutrients

in foods and for utilizing synthetic vitamins to supplement deficient dietaries. Further research was considered necessary in the following fields: (1) Improvement of presently known chemical and biological procedures for estimating the amounts of the essential nutrients in foods and their physiological availability; (2) more refined technics for the detection of nutritional deficiency states, especially in the subclinical degrees of intensity; (3) more precise determination of the optimum and minimum requirements of human subjects for each of the nutrients, as influenced by age and physiological status (including pregnancy and lactation) and those factors which affect their utilization; (4) study of problems relating to the nutritional needs of the individual as influenced by constitutional inefficiencies, by suboptimal nutrition, by disease and convalescence; (5) studies directed toward clear definition of the physical status of the individual; (6) study of all factors affecting the nutritive value of foods and their preservation during the interval between production and consumption; (7) study of methods of preparation of foods for consumption so as to avoid losses of nutrients; (8) food habits and methods and effects of changing them. The section also authorised the appointment of a committee "to survey existing facilities in all the universities, agricultural and land-grant colleges, or other laboratories of the country fitted to carry out substantial portions of the general research programme outlined in the report as adopted, and include in this survey an estimation of additional funds which may be necessary to effect promptly and efficiently the execution of these researches."

The Conference advocated "more widespread education of doctors, social-service workers, teachers and other professional workers in the newer knowledge of nutrition".

Virus Detection.—A new method of detecting viruses, toxins, and poisons in liquids is disclosed in a patent issued to Irving Langmuir, 1932 Nobel Prize Winner, of General Electric Research Laboratory, Schenectady, N.Y.

Used in the method is a conditioned slide on which 47 layers of transparent barium stearate, each of 0·0000001 inch thick, have been formed. This makes it possible to apply to the slide a substance with a specific reaction toward the toxin, virus, or poison suspected present. The slide is dipped in the solution to be tested and, if the suspected substance is present, adsorption of a single layer of uniformly thick atoms or molecules of the substance will produce an increase in film thickness and a corresponding change in colour. The films are illuminated by sodium light, and changes in intensity of the yellow sodium light are measured.

Each type of substance in solution is expected to produce a characteristic increase in film thickness and corresponding colour change. Once standards for known substances have been determined, identification of suspected substances will be a matter of check and comparison. Katharine B. Blodgett and Vincent J. Schaefer of the research laboratory staff have assisted Dr. Langmuir in the investigations, which started in 1935.—(*Current News of Chem. and Chem. Eng.*, 1941, 19, 377.)

Insect Pests of Jute.—For the protection of jute plants from insect pests, detailed life-histories of the parasites are being worked out at the Jute Research Laboratories of the Indian Central Jute Committee (*Bulletin of the Indian Central Jute Committee*, Sept. 1941). Attempts are made to devise suitable control methods for each pest, and the economics of control-measures is kept in the fore-front of the investigations. For example, while it has now been discovered that both the indigo-caterpillar and semi-looper can be controlled by spraying with lead-arsenate, it has also been ascertained that other agricultural and biological measures, besides being cheaper, are equally efficient if carried out in time. Growing of protective *til* borders around jute is quite efficacious against indigo-caterpillars. If perches are provided when the crop is only two feet high, the birds will prey on semi-loopers and keep them in check. But once the pests have got out of hand, only spraying with lead-arsenate will control the indigo-caterpillar and semi-looper.

Malaria Institute of India.—Whilst the research activities of the Institute have been restricted owing to war conditions, there has been an expansion of the training courses held during the year, says the Annual Report of the Malaria Institute of India for 1940. Special courses have been arranged for military personnel, whilst for the first time malaria courses for Engineers were held at the Field Station of the Institute in Delhi. The latter were attended by 61 Engineers, representing various branches of their profession, from widely seperated parts of India.

Officers of the Institute have continued to supervise the anti-malaria campaign which has been carried on in and around Delhi over an area of 55 square miles. Advice has also been given regarding the rural malaria schemes which are in progress in different parts of India. Special research units have carried out investigations in the Wynaad, South India, in the United Provinces Terai and in the neighbourhood of the Chilka Lake, Orissa.

A number of publications dealing with various branches of malariology have been published by members of the staff, and advice on malaria control measures has been given to a number of workers throughout India. In addition to malaria, problems connected with filariasis and the possible introduction of yellow fever into India have been dealt with.

Fish which feed on the larvæ of mosquitoes have been supplied to various health authorities from the hatchery maintained in Delhi. A number of larvicides and insecticidal sprays have been tested at the Field Station, and the routine examination and identification of mosquitoes sent to the Institute from different parts of India have been carried out as in previous years.

On April 1, 1940, the Public Health section of the Institute was taken over by the Government of India. Prior to that date, the whole of the activities of the Malaria Institute of India were financed by the Indian Research Fund Association.

Flora of the Punjab and the Associated Hill Regions.—Dr. T. S. Sabnis has continued in Part II (*J. Bombay Nat. Hist. Soc.*, 1941, 42,

No. 2) the list of plants reported in Part I. The locality and distribution of each species is given. The flora of the Punjab and the Associated Hill Regions will appear in several parts of which two are now published.

L. S. S. K.

The Centenary of the Chemical Society, London, was celebrated on April 3. At the annual meeting Sir Robert Robinson, the retiring president, delivered an address. Dr. J. C. Philip was elected president for the coming year.

The Society was inaugurated in 1841 by Mr. Warington with seven or eight other members of the Mathematical Society of Spitalfields. In 1848 the Society obtained a Royal Charter. The Society has on its roll several distinguished scientists among whom mention may be made of the following: Graham, Hofmann, Williamson, Faraday, Joule, Balard, Bunsen, Cannizzaro, Chevreul, Dumas, Gay-Lussac, Helmholtz, Kekulé, Laurent, Liebig, Mendeléef, Pasteur, Stas, Thénard, Wöhler, and Wurtz.

Thin Glass for Microscope Cover-slips.—The year 1940 marked the centenary of the manufacture, in Great Britain, of specially thin glass for microscope cover-slips. Prior to this date, it was customary for microscopists to use thin talc or mica for covering specimens to be examined under the microscope. This manufacture was started by *Messrs. Chance Brothers and Co., Ltd.*, at Smethwick, in 1840 as nearly as is known, and has been carried on continuously by the same firm up to the present day. The war has called for a considerable increase in supplies of such glass, both in Great Britain and abroad. There was no essential change in this type of glass until about 1928, when a research was carried out on the development of microscope cover-slips. It was found that the old type of glass which was essentially like window glass, would not withstand tropical conditions without becoming clouded. Therefore new methods of manufacturing a glass which would withstand sterilizing and exposure to tropical atmospheres without any deterioration were introduced. The thickness of cover-slip glass is still classified under the headings: Extra thin (0·075-0·100 mm.), No. 1 (0·100-0·167 mm.), N. 2 (0·167-0·215 mm.), and No. 3 (0·215-0·300 mm.). These correspond closely with the figures quoted in a catalogue issued by the firm in March 1859, which says No. 1 is 1/250 in. in thickness, No. 2 1/160 in., and No. 3 about 1/100 in.

—(*Nature*, 1941, 147, 803).

Scientific and Industrial Laboratories in Canada.—A bulletin giving the results of a survey of scientific and industrial laboratories has recently been completed by the Dominion Bureau of Statistics in collaboration with the National Research Council. The inquiry, the first of its kind ever undertaken in Canada, was designed primarily to secure information necessary for the effective prosecution of the war but the statistical data obtained were considered of sufficiently general interest to warrant the publication of a report thereon.

An important feature of the bulletin is the appended directory of laboratories, prepared in the Research Plans and Publications Section of the National Research Council, which lists, by ownership, the names and addresses of the industrial and scientific institutions which co-operated in the survey. The urgency of the demand for the information respecting laboratory facilities made it inexpedient to attempt a complete census of laboratories at the time the inquiry was undertaken, but it is felt that the survey includes practically all the more important and better equipped institutions, as well as a large majority of the smaller laboratories in Canada. The industrial section of the directory is accompanied by a key, by the use of which the types of work the various laboratories reported themselves as equipped to carry on, may be identified.

Copies of the Survey of Scientific and Industrial Laboratories, N.R.C. No. 961, may be obtained on application from the National Research Council. The price is $1.00, and remittance should accompany the order.

Indian Central Cotton Committee: Technological Laboratory.—"A feature of the year is the arrangement entered into between the Indian Central Cotton Committee and the Supply Department of the Government of India, whereby the Laboratory has been recognised as the official testing house for cotton mills in the Bombay Province, and the reports issued by it are accepted as being authoritative", states the Report of the Director, Technological Laboratory, for the year ending May 31, 1941, just published. This arrangement has proved helpful to the mills in the Bombay Presidency in getting their development samples and samples submitted against tenders tested expeditiously, and has at the same time brought the work of the Laboratory in close touch with the textile industry.

"Last year, the total number of samples tested at the Laboratory was 768, as compared to 1,800, during the year under review. A new section has been added to the Laboratory for the study of the ginning problems of Indian cotton and the machines required for the purpose have been installed. Some preliminary ginning tests with different speeds and settings on several varieties of Indian *kapas* have also been carried out.

"The samples tested at the Laboratory are dealt with in spinning test, yarn test and cloth test reports, which are issued on these samples. Last year, the number of these reports stood at 261, as against 1,046 during the year under review. Among the tests made on samples received from agricultural officers were Jarila cotton, which is now spreading rapidly in Khandesh; "Agmark" samples of 1027 A.L.F. from Baroda and adjoining British territory; medium-long staple cottons which are being tried in Bengal; and Gaorani-6 which is now cultivated over a fairly large area in Hyderabad State.

"The Laboratory investigated the causes of difficulties referred to by various mills, such as tendering of cloth, appearance of stains and the presence of holes in the cloth and the reports issued to the mills contained suggestions for preventing such defects.

"The technological investigations under progress included the pre-cleaning and ginning of Indian seed cottons on different machines and with different settings and speeds, the effect of different treatments in the blow-room, effect of storage under Bombay conditions on the quality of Indian cottons, the influence of swollen hair diameter on the spinning quality of cottons, fibre properties in relation to seed characters, efficiency of kier boil and bleach treatments.

"Work on Indian linters was continued during the year, and samples of linters for the past two seasons were analysed both by mechanical treatment and chemical process and the relationships between the results of the two treatments were worked out."

Tata Iron & Steel Company, Limited.—The annual report for the year 1940–41 reveals that, during the year, a large number of new schemes were taken on hand and successfully worked. Thus, the manufacture of bullet-proof armour plate steel has been developed and such steel is being made for the requirements of armoured vehicles in India. Special steels have been developed for armour piercing bullets and shells, for machine guns as well as for rifle and machine gun magazines and for drawing into telegraph wire. Research has been successfully pursued in connection with the welding of chrome molybdenum steel required for aircraft. The company is in a position to manufacture a large variety of special steels which had so far been imported. During the year, work was started on the erection of the new steel-making plant forming part of the current programme of expansion of the Works. This plant will produce steel by an entirely new process developed at Jamshedpur, which will not only enable steel to be made more rapidly than by other processes but will also enable acid steel to be produced for the first time out of purely indigenous materials. The plant is expected to be in operation before the expiry of the current year. An electrode-making plant for the manufacture of welding electrodes was put into operation in December 1940. A plant for manufacture of wheels, tyres and axils is being erected, and when this comes into operation, it will be possible to manufacture in India all the component parts required for railway locomotives.

Fishery Technology.—The Government of Madras have directed the establishment of an Institute at Tuticorin for the training of teachers in Fishery Technology, after their regular training in teachers' training schools. The Institute is intended to provide for a course of instruction to fishermen and others in all branches of fishing industry, including navigation.

The Institute will be started with 25 students. The duration of the training will be one year and for those who wish to specialise it will be extended to 2 or more years. *The Bharati Mahajan Sangam* and others will award 15 scholarships for the students of their community and the Government will provide for a grant of six stipends. A fee of Rs. 5 will be charged for students outside the Presidency.

Calcutta University.—Mr. Nirmalendunath Ray, M.Sc., has been admitted to the Degree of Doctor of Science in consideration of his thesis entitled "A Study of the analogy of the Complexes fluoberyliates and sulphates".

University of Mysore.—The Institution of the Degree of Master of Engineering and the Doctorate [D.Litt., D.Sc., D.Engg., D.Sc. (Anatomy and Physiology)] has been sanctioned.

The following extension lectures were delivered:—Dr. R. E. Heilig: "Vitamin and Preservation of Health"; Dr. C. S. Pichamuthu: "Was Mysore ever under the Sea?"; Dr. D. Jivanayakam: "Mass Education in India"; Madamme Sophia Wadia: "Ideas which Rule the World"; Dr. L. Sibaiya: (1) "Architecture of Atoms"; (2) "Atoms and Spectra".

Imperial Agricultural Research Institute, New Delhi.—The following students of the Institute have been awarded the Diploma of the Institute (Assoc. I.A.R.I.) after the completion in September 1941, of their two-year post-graduate courses and the acceptance by the Institute Council of theses submitted by them as mentioned against each:—

Botany—

(1) D. Srinivasachar: "Studies in the classification of *Oleiferous brassicæ* in India. (2) A. R. Braganza: "Seed and Embryo weight in its Relationship to Heterosis". (3) K. D. Sharma: "Morphology and classification of the varieties of *Solanum Andigenum* Juz. *et* Buk. and their breeding value."

Agricultural Chemistry—

(4) D. K. Patel: "Studies on Phosphate—Fixation in Indian cultivated soils." (5) M. K. Reddy: "The study of the Plate and the direct methods for the estimation of total Bacterial numbers in the soil with special reference to the variation of sampling errors with grain size."

Entomology—

(6) Shumsher Singh: "A contribution to the study of Indian *Terebrantia* classification of Terebrantia with a Systematic Account of the North Indian genera and species, their distribution and food plants." (7) Chandra Narain Modawal: Part I.—"Studies on the Life-history and Bionomics of *Chilomenes sexmaculata* Fabr., and its Predatory Efficiency in the Biological control of Aphids." Part II.—"Review of previous work on the more important pests of cotton in India."

Mycology—

(8) Syamaprasad Ray Chaudhuri: (i) "Studies on the canker disease of pigeon-pea [*Cajanus cajan* (L) Millsp.] caused by *Diplodia cajani* Nov. spec." (ii) "Studies on *Erysiphe cichoracearum* Dc and *Erysiphe polygoni* Dc.

Sugarcane Breeding—

(9) Gur Prasad Seth: Part I.—"Sugarcane Breeding as adopted at Coimbatore." Part II.—"Different factors in Sugarcane germination with special reference to nature of soil, its moisture content and variety." Part III.—"A possible method for selecting high yielding sugarcanes. (10) Jagdish Narain Sharma: Part I.—"Sugarcane Breeding at Coimbatore." Part II.—"Age determination of a sugarcane

culm." Part III.—"On the formulæ of branching system of some of the sugarcane varieties in relation to poor harvest in some of them." Part IV.—"A preliminary study of root primordia in certain sugarcane seedlings and their parents.

The following students have successfully completed the one-year post-graduate course in Agriculture:—

(1) Kanshi Ram Chowdhry. (2) K. L. Gurnani.

ASTRONOMICAL NOTES

Planets during November 1941.—Venus continues to be a very brilliant object in the western sky visible for nearly three hours after sunset; it reaches greatest elongation from the Sun (47° 16′ E.) on November 23 when its stellar magnitude will be −4·0. It will be bright enough to be seen, when carefully looked for, even during daytime and will cast a faint shadow by night. Mercury is a morning star and will be at its greatest elongation (19° 11′ W.) on November 12; will also be bright at the time, the magnitude being −0·3. Mars will be gradually decreasing in brightness, but is still a prominent object in the evening sky, setting about three hours before sunrise. It will be stationary on November 12 when it resumes its eastward motion among the stars. The Moon will be in close conjunction with the planet on November 1 and again on November 28.

Jupiter rises about an hour after sunset and is very conspicuous in the night sky during the month; its magnitude increases to −2·3. Saturn is in opposition to the Sun on November 18 and will be on view nearly the whole night as a bright star of magnitude −0·1. The ring ellipse will reach the maximum width for the year, the angular dimensions of the axes being 46″·1 and 18″·2. Uranus which is close by, will be in opposition on November 21, and can be seen as a faint star (magnitude 5·9) just visible with the naked eye about 4° south of the beautiful star cluster Pleiades.

The Leonid meteoric showers are due to appear about the middle of the month; the date of maximum display is November 16 and the meteors may be looked for about a week before and after that date. The radiant point is given by R.A. 151°. Declination 23° N. Another well-known shower due to appear in November is the Andromedids, the approximate date of maximum being November 17–27. The position of the radiant is R.A. 25°, Declination 44° N. and the meteors of this group are characterized by very slow short paths.

T. P. B.

SEISMOLOGICAL NOTES

During the month of September 1941, two slight and eight moderate earthquake shocks were recorded by the Colaba seismographs as against four moderate and six slight ones recorded during the same month in 1940. Details for September 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
September 1941		H.	M.	(Miles)		(Miles)	
4	Moderate	15	52	5560	Near Lat. 8° S., Long. 153° E., in the neighbourhood of New Britain		
9	Moderate	12	50	5660	Apparently in the neighbourhood of New Britain	Deep	
10	Slight	15	41	490			
11	Moderate	03	24	2250			
12	Moderate	12	33	3870			
17	Moderate	03	13	6930			
17	Moderate	12	18	3370			
22	Slight	00	23	1490			
24	Moderate	06	31	4950	Lat. 47°·7 N., Long. 158°·4 E. in the neighbourhood of the Kurile Islands in the North Pacific		
29	Moderate	08	02	840	Lat. 29°·9 N., Long. 67°·2 E. within 20 miles from Quetta		Reported to have been felt strongly in Quetta and its neighbourhood

MAGNETIC NOTES

The average magnetic activity in the month of August 1941 was slightly more than that in the preceding month. There were 1 quiet day, 21 days of slight disturbance and 9 of moderate disturbance as against 6 quiet days, 23 slightly disturbed and 2 moderately disturbed days in August 1940. On the 4th August 1941, the magnetic activity was the highest and on the 8th August, the least. The character figures of individual days in August 1941, are given below:

Quiet days	Disturbed days		
	Slight	Moderate	Great and very great
8	1, 3, 7, 9, 10, 11, 12, 13, 14, 15, 16, 19, 20, 21, 22, 23, 25, 26, 29, 30 & 31	2, 4, 5, 6, 17, 18 24, 27 & 28	Nil

A moderate disturbance suddenly commenced at 1^h 28^m G.M.T. on 4th August 1941, and ended at 2^h 30^m G.M.T. on the next day. There were no magnetic disturbances during the same month in 1940. The mean character figure for the month was 1·26 as against 0·87 for August 1940.

ANNOUNCEMENTS

University of Bombay.—The following awards have been announced. Intending competitors, who should be graduates (or undergraduates in the case of 2) of the University of Bombay, should send in their essays on the subjects notified before the last Monday in September, 1942; the last date for sending the essay for the Ashburner Prize is last Monday in September 1943. Essays should be typewritten or written in a neat legible hand and should not exceed 100 pages in length. Further details can be had from the Bombay Government Gazette, October 2, 1941:

1. *The Monockjee Limjee Gold Medal,* 1942. (Rs. 175. The winner will also receive a prize of Rs. 425 in cash or books.) "The contribution of the Indian Scientists to the development of industries in India."
2. *The Homejee Cursetjee Dady Prize,* 1942. (Rs. 600.) "Aviation with special reference to Indian conditions."
3. *The Dossabhoy Hormusjee Cama Prize,* 1942. (Rs. 630.) "Undernutrition in India, a survey of its effects and methods for overcoming it."
4. *The Ashburner Prize,* 1943. (Rs. 240.) "The need for planning a programme of Indian agriculture with reference to economic and industrial requirements of the country."
5. *The Pandit Bhagwanlal Indraji Gold Medal,* 1942. (Rs. 175.) "Prehistoric cultures of India."

Carmichael Medical College Silver Jubilee Celebration.—The authorities of the Carmichael Medical College and Hospitals have decided to celebrate the Silver Jubilee of the Institution towards the end of this year.

Sir Nripendranath Sircar has been elected Chairman of the Jubilee Committee. A Working Committee with Sir Nilratan Sircar as Chairman and nine sectional committees have been formed to work out the details of the programme.

The authorities of the Institution, in celebrating its Jubilee, consider the function as one of stock-taking. While its achievements and growth have been remarkable, they realise that much more remains to be done.

The Jubilee Celebration Committee looks forward to the sympathy and support of every one interested in the development of scientific institutions in this country, in their work.

Chronica Botanica Co., Waltham, Mass., U.S.A.—The following plant science books are due to be published shortly:—

"Forest Tree Seed," by H. I. Baldwin, Research Forester, New Hampshire Forestry Dept. Summarizes existing information on the collection and treatment of tree seeds prior to sowing, the physiology of seed, and methods of testing for germination and other qualities. Research methods, and co-operation in research are stressed. A selected bibliography and a polyglot glossary of terms will be included. *In the press, ready shortly.* About 240 pages, illustrated, buckram, $4·50.

"Cytoplasm," by A. Guilliermond, Professor of Botany at the Sorbonne, Paris. Authorized American translation by Lenette Rogers Atkinson of Amherst, Mass. A critical review of our present knowledge of the cytoplasm and its morphological constituents by the eminent French cytologist. Morphological, physical and chemical properties of the cytoplasm. Plastids, Chondriosomes, Vacuome, Microsomes. Other cytoplasmic formations. Cytoplasmic alterations. Vital staining. Modern conceptions in plant cytology, etc. *Ready shortly.* About 250 pages, over 150 illustrations, buckram, $4·50.

"An Introduction to Pollen Analysis," by G. Erdtman, Vasteras, Sweden. An account of the principles and methods used in research on pollen, especially in pollen analysis of peat, and an outline of the more important results so far achieved. The practical applications of pollen research to archæology, forestry, phytogeography, etc. are fully treated. Special consideration is given to the experimental aspect of the problems involved and to possible lines of approach to new fields of activity in this rapidly growing branch of science. From the contents: Pollen preparations, Bog investigations, Preparation of samples, Pollen production, Wind transport, Pollen and spore morphology (mosses, ferns, gymnosperms, angiosperms), Pollen diagrams and their interpretation. *Ready shortly.* About 240 pages, illustrated, several hundred original drawings, buckram, $5·00.

"A Short History of the Plant Sciences," by Howard S. Reed, Professor of Plant Physiology, Univ. of California. The discovery of plants and their cultural uses by ancient peoples. Botany of the Greeks, Romans, Chinese and

Arabs. The renaissance of scientific botany in Europe. Botanical explorers: the effects of the discovery of the New World. Contributions of botany to agriculture and forestry. The rise of specialization: its results in the nineteenth and twentieth centuries. Reviews of investigations in the specialized fields of botany and related sciences. To be published shortly. About 240 pages, illustrated.

"Carnivorous Plants," by Francis E. Lloyd, Professor of Botany Emeritus, McGill Univ. A general and full account of the carnivorous plants of the world, of which upward of 500 species belonging to 15 genera are known among the flowering plants and several others among the fungi. The descriptions, embracing their appearances, habitats, geographical distribution, anatomy and morphology and so much of their physiology as is concerned with the carnivorous habit, are based in large part on the Author's personal study of material of all types derived by exploration and by correspondence with botanists in all parts of the world. Fully illustrated with original drawings and half-tones, some 250 figures in all. In preparation, ready shortly.

Symposium on Corrosion.—An outstandingly successful symposium on the extremely important subject of corrosion was organised by Section C of the American Association for the Advancement of Science, with the assistance of a special co-ordinating committee of representatives from practically all the important scientific and technical associations in America. The symposium was held during the first week of August, and was attended by nearly 70 invited corrosion specialists; including among others F. N. Speller, William Blum and H. H. Uhlig. A variety of corrosion aspects were discussed: *e.g.*, "Statistical methods in corrosion studies," "Protection of metals with metallic coatings," "Anodic oxide and surface conversion coatings," "New corrosion resistant steels," "Corrosion of metals by soils," "Theory of cathodic protection," etc.

* * *

We acknowledge with thanks, receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4590–91.

"Journal of Agricultural Research," Vol. 62, Nos. 10–12.

"Agricultural Gazette of New South Wales," Vol. 52, Part 8.

"Indian Journal of Agricultural Science," Vol. 11, Part 4.

"Biochemical Journal," Vol. 35, No. 4.

"Journal of Chemical Physics," Vol. 9, No. 8.

"Journal of the Indian Chemical Society," Vol. 18, Nos. 6 and 7.

"Experiment Station Record," Vol. 85, No. 1.

"Indian Forester," Vol. 67, No. 10.

"Transactions of the Faraday Society," Vol. 37, Parts 6 and 7.

"Indian Farming," Vol. 2, No. 9.

"The Review of Applied Mycology," Vol. 20, Part 6.

"Bulletin of the American Meteorological Society," Vol. 22, No. 6.

"Journal of the Indian Mathematical Society," Vol. 5, No. 2.

"Journal of Nutrition," Vol. 22, No. 2.

"Nature," Vol. 147, Nos. 3738–39; Vol. 148, Nos. 3740–42.

"The Philippine Journal of Science," Vol. 75, No. 2.

"Indian Journal of Physics," Vol. 15, Part 3.

"Journal of Research" (National Bureau of Standards), Vol. 27, No. 1.

"Sky," Vol. 5, Nos. 10–11.

"Science and Culture," Vol. 7, No. 4.

"Sankhya," Vol. 5, No. 3.

"Indian Trade Journal," Vol. 142, Nos. 1838-41.

BOOKS

"Chemical Species," by Jean Timmermans. (Macmillan Co., London), 1941. Pp. viii + 177. Price 18*sh.*

"Mercerising," by J. T. Marsh. (Chapman & Hall, London), 1941. Pp. xv + 458. Price 32*sh.*

"Surge Phenomena, Seven Years' Research for the Central Electricity Board (1933–40)," published by the British Electrical and Allied Industries Research Association, London, 1941. Pp. viii + 426. Price £2–10–0.

"Intermediate Electricity," by Robert W. Hutchinson. (University Tutorial Press, London) (Cambridge University Press, Bombay), 1941. Pp. viii + 628. Price 12*sh.* 6*d.*

"The Photochemistry of Gases," by William Albert Noyer and Philip Albert Leighton. (Reinhold Publishing Co., New York), 1941. Pp. 475. Price $10·00.

"The Second Year-book of Research and Statistical Methodology," edited by Oscar Krisen Buros. (The Gryphon Press, New Jersey), 1941. Pp. xx + 383. Price $5·00.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

September 1941. SECTION A.—SIR C. V. RAMAN, V. S. RAJAGOPALAN AND T. M. K. NEDUNGADI: *Conical refraction in naphthalene crystals.* The angles of internal and external conical refraction for naphthalene are exceptionally large (13° 45′) and the substance is well suited for exhibiting these phenomena as well as for a critical study of same. The so-called Poggendorff circle appears only in internal conical refraction and is an ultra-focal phenomenon. SIR C. V. RAMAN: *New methods in the study of light scattering. Part I. Basic ideas.* A method is described, based upon the use of a Nicol for polarising the incident beam in any desired azimuth, and of a Babinet compensator for observing the transversely scattered light which enables the Krishnan effect to be very conveniently studied. T. A. S. BALAKRISHNAN: *New methods in the study of light scattering. Part II. Pure liquids.* Using a Babinet compensator with an analysing nicol oriented so as to transmit vibrations in the plane of observation, the author has established the presence of a feeble partial polarisation in the scattered light. T. M. K. NEDUNGADI: *Studies on the Raman effect in single crystals of potassium nitrate.* New lattice vibrations at 100, 126 and 143 are recorded. These disappear just below the transition temperature of 129° C. There is no conspicuous change in the internal oscillation frequency shifts due to change of state. T. A. S. BALAKRISHNAN: *Effect of crystal orientation on the Raman spectrum of barytes.* None of the three orientations of the crystal gives the complete Raman spectrum, some of the components vanishing in particular orientations, while the intensities of the others vary. P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Constitution of cannabiscitrin.* Cannabiscitrin is a monoglucoside of the flavanol cannabiscetin, carrying the sugar group in the side phenyl nucleus in the 3′-position. S. V. ANANTAKRISHNAN AND S. KRISHNAMURTI: *Kinetic studies in ester hydrolysis. Part I. The hydrolysis of halogeno-aliphatic esters.* S. V. ANANTAKRISHNAN AND S. KRISHNAMURTI: *Kinetic studies in ester hydrolysis. Part II. The influence of solvent on the reaction.* P. SURYAPRAKASA RAO AND T. R. SESHADRI: *Isolation and constitution of quercetagitrin, a glucoside of quercetagetin.* T. R. SESHADRI AND V. VENKATESWARLU: *Nuclear methylation of β-resorcylic aldehyde.* K. NEELAKANTAM AND L. RAMACHANDRA ROW: *The constitutional features of anthoxanthins in relation to the morin reaction in analytical chemistry. Part I. Some naturally occurring hydroxy-flavonols and flavonones.* SAHIB RAM MANDAN: *A relation between a pencil and a range of quadrics.*

SECTION B.—BHOLA NATH SINGH: *The growth of the sugarcane plant in India. Part I. Age-fertiliser effects on the physiology and chemistry of sugarcane.* SYED IMDAD HASSAN: *The shell and the mechanism of its closure in the Indian pond terrapin, Lissemys punctata punctata (Bonnaterre).* VIJAY PRATAP SINGH: *On a collection of algæ from the Chamba State, Panjab—I.* VIJAY PRATAP SINGH: *The chlorophyceæ of the Benares district, India—I.* T. C. SARKAR: *The alteration of radioactive minerals.* G. W. CHIPLONKER: *Ammonites from the Bagh beds.* RUSTOM JAL VAKIL: *An analysis of two hundred normal electrocardiograms.* P. KRISHNA RAO: *Infantile cirrhosis of the liver.* G. D. BHALERAO: Subulura minetti *n. sp. (Nematoda from an Indian fowl.*

Indian Association for the Cultivation of Science: (*Proceedings*)

June 1941.—(MISS) CHANDRAKANTA: *Measurement of acoustical impedances.* G. R. PARANJPE AND D. J. DAVAR: *Determination of dipole moment in solution.* N. RAJESWARA RAO: *Electrolytic dissociation in Nitric acid as studied by Raman effect.* D. S. SUBRAHMANYAM: *Friction between a liquid surface and a solid not wetted by it.* N. R. SEN: *On a theoretical estimate of an upper limit of Stellar diameter.* N. R. SEN: *On some thermodynamic properties of a mixture of gas and radiation.* J. G. BECKERLEY: *The calculation or arg* $\Gamma(ia + i)$. H. BOSE AND B. B. RAY: *Allotropies of tellurium by X-ray diffraction method.*

August 1941.—S. M. KERAWALA: *A rapid method for calculating the least squares solution of a polynomial of degree not exceeding the fifth.* H. BOSE: *Investigation of tellurium and arsenic sulphide in the colloidal state.* CHAMAN LAL: *Measurement of the angle of incidence at the ground of downcoming short-waves from the ionosphere.* B. SWAMINATHAN: *The short wave condenser field.*

Indian Chemical Society: (*Journal*)

July 1941.—A. L. SUNDARA RAO: *Studies in hydrogen bond formation. Part I. Amides.* S. S. BHATNAGAR, N. A. YAJNIK, P. L. KAPUR AND ANAND SWARUP BHATNAGAR: *Magnetism and catalysis. Part III. Chlorination of chloroform to carbon tetrachloride in presence of Ferric chloride.* R. K. BAHL AND MANOHAR LAL: *The action of chlorine on the hydroxides of iron and chromium in the presence of iodine.* G. GOPALARAO AND CH. I. VARADANAM: *Photosensitisation of solids. Part III. Photosensitised oxidation of ammonia in aqueous solution with colloidal titania as the photosensitiser.* S. S. BHATNAGAR, P. L. KAPUR, ANAND SWAROOP BHATNAGAR AND BRAHM PRAKASH: *Magnetism and catalysis. Part IV. Catalysis of the reaction between ammonium oxalate and mercuric chloride by ferric ions.* JYOTIRMOY DAS-GUPTA: *micro-analytical method for the estimation of ferrous and ferric iron in minerals.* JYOTIRMOY

DAS-GUPTA: *Microchemical investigations on spotted muscovite mica.* P. V. KRISHNAMURTHY: *Complex formation by ascorbic acid with formaldehyde.*

Indian Botanical Society: (*Journal*)

October 1941.—P. MAHESHWARI: *Recent work on the types of embryo-sacs in Angiosperms—A critical review.* V. PURI: *The life-history of* Moringa oleifera *Lamk.* GHIAS-UD-DIN AHMAD: *The growth of* Azolla filiculoides *in mineral solution without addition of 'Auximone'.* M. J. THIRUMALACHAR: Hapalophragmium ponderosum *Syd. on* Acacia leucophlæa *Willd.* B. G. L. SWAMY: *Contributions to the life-history of* Bignonia megapatomica. T. S. RAGHAVAN AND A. R. SRINIVASAN: *Cytogenetical studies in nicotiana.* T. S. RAGHAVAN AND K. RANGASWAMY: *Studies in the Rubiaceæ.* K. N. SESHAGIRIAH: *Morphological studies in Orchidaseæ. I.* Zeuxine sulcata *Lindley.*

Geological, Mining and Metallurgical Society of India: (*Journal*)

The latest issue of the *Quarterly Journal of the Geological, Mining and Metallurgical Society of India* (*Vol.* XII, No. 4) contains a short paper by Mr. K. L. Bhola on Fuller's Earth deposits of Jodhpur State, Rajaputana. After giving a brief account of the geology of the area in which these deposits are found, the paper proceeds to give a description of the different deposits, together with the results of the tests conducted on the suitability of this material for various purposes—from which it appears that the quality is fairly satisfactory.

Mining, Geological and Metallurgical Institute of India: (*Transactions*)

The recent number of the *Transactions of the Mining, Geological and Metallurgical Institute of India* (Vol. 36, Pt. 2) contains a report of the contribution by Dr. S. K. Roy to the Discussion on Mr. Hobson's paper on "The development of the mineral deposit at Mawchi as determined by its geology and genesis" read some time back before the Society. In the course of his observations, Dr. Roy offers an explanation of the fact that the tinstone veins pinch out at the approach of the limestone on the basis of the experimental work by Dubrée and Gay Lussac. He also refers to the view of Mr. Hobson that the Mawchi ores were not formed under conditions of slowly falling temperature but under conditions of rapidly decreasing pressure and points out that this is not quite in agreement with observations made by Niggli based on his and Smits' experiments in Carnegie Institute.

The *Journal* also contains a valuable paper by Mr. James Lomax on "Some aspects of Surveying in Indian Coal Mines", at the end of which there is also a full Report of the Discussion on this subject in which Messrs. W. Kirsby, K. B. Swami, C. Forrester, J. K. Dholakia, H. K. Nag and others have taken part.

Meteorological Office Colloquium, Poona:

September 9, 1941.—J. M. SIL: *Some aspects of fluid flow and fluid resistance.*

September 16, 1941.—S. MAL: *The structure and movement of western disturbances.*

September 24, 1941.—B. N. DESAI: Frontal *analysis of two winter depressions of Northwest India.*

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SCIENCE TO RE-BUILD

MANY scientists have naturally been moved by the horrors of the war to re-examine the scope and content of their moral responsibility as men of science towards humanity. Evidence of this humane anxiety on their part is to be seen in the proceedings of the British Association which held a conference of distinguished scientists of many nationalities in London in September last.

Indeed, no scientist that has not been altogether dehumanized by scarabeeism can help admitting that the modern war (as distinguished from wars of antiquity) is a by-product—an altogether unintended one, it is true; but a by-product nevertheless—of his own workshops. Science has abolished the serene isolation of countries, complicated and queered their economic organization, kindled in them new greeds and new rivalries, and furnished deadlier weapons than were ever available before to their hands. This list of the doings of science is of course only one of the many lists possible; and the other lists are, everyone would thankfully acknowledge, as greatly gratifying as this one is grim. But can there be no helping of these dark spots? Cannot science do something to repair the damage done to life and civilization by the cupidities which its triumphs have brought into play? To think of the various social problems raised or enlarged by science and consider how she could be of service in re-building the world of man now being shattered by forces which her own progress has released, is a responsibility implicit in the influence that belongs to the scientist.

Science may claim that in herself she is non-moral and that she is not to be held responsible for the purposes for which her handiwork has been used or abused by statesman or soldier or manufacturer. To take this stand is, however, not to exalt science, but to lower her status and diminish her significance. To say that a thing is non-moral is not different from denying to it the endowment of anything like soul or conscience. Will science take it as a compliment to be counted a thing blind and heedless and mechanical? Is science to be pursued as an end in itself, or is it to subserve some other purpose connected with our life? In itself innocent, it produces things potent for mischief. Our cook is indeed a most innocent person; but the flavours he sets afloat from the kitchen will not melt away before stirring up the gastric juices of persons equally innocent moving about in the garden. There can be no transaction or occurrence within the field of man's experience,—not so much as the casual glimpse of a face or the chance hearing of a cry,—which can hope to escape registration in the ledger-book of life; and no entry can be there without its credit or debit value in terms of the psychological and character-affecting consequences of the act or the experience. Nothing, strictly viewed, is non-moral,—not even science. The scientist claims that his supreme interest is in truth. Why truth? Of what significance is it? Is it nothing more than curiosity, idle and devoid of meaning and purpose?

The scientist cannot hope to ward off blame by designating himself a simple catalyzer. If that similitude must be kept on, he is, unlike a merely chemical substance, a conscious catalyzer. He surely knows whether what he is helping to produce is medicine or munition, food or poison; and the responsibility with which the world charges him is in relation to his capacity as a human being. Must science dehumanize man? May the scientist remain unconcerned seeing the monstrous misuse of the products of his skill?

The remedy is not to exile science, but to invite more of it. Great as her conquests have been, science has yet to conquer more before her victory could be taken as completed; and these further conquests are to be achieved by her in intimate collaboration with an alert and generous humanism. The misfortune of mankind to-day is that the extent of control over external nature which science has been able to secure for man has not been equalled by the extent of control which he has been able to acquire over his own nature. Hence all the prostitution of the resources of science. Novel, adventurous, utilitarian, marketable, science has gone forward from success to success, not pausing to heed the gentle and steadying voice of the humanistic tradition in our civilization. She has preferred to see man go about hopping on one foot. Science's disregard of the older philosophy is perhaps her only unscientific act.

The universe, it is at least arguable, is a compound of the physical and the trans-physical or transcendental. But science's early successes were in the region of the physical. She penetrated far into what had previously been regarded as the mystery zone of nature and extended the frontiers of the measurable and the explainable. In the first flush of these triumphs, it looked as though there could be really no limit to

what the marching intelligence of man can unveil and capture and subdue. It followed from this that what the microscope could not reveal could not possibly exist and therefore did not exist; that reality is reality only if it could be measured by the sicentist's inch-stick. No other tests were to be trusted. The whole host of witnesses from the realms of religion and literature and art were simply out of court. Thus came about the exaltation of the physical and the materialistic and the obscuration of the transphysical and the spiritual. This was just a counter-part of the error that some of the post-Vedic faiths of India fell into, namely—the belittlement of the mundane and the exaggeration of the supra-mundane. The scales of relative value of both schools must, by the same method of reasoning that true science works by, be set down as erroneous. Our ills of to-day are the off-spring of that imperfect correlation, so to say, between the two quantities of life—a *A* and an *N*—one accessible to our analysing and proving and the other only to be "sensed" subjectively, at moments of intense inward experience and unavailable to objective proving.

The services of science to mankind may roughly be classified under three heads:—

(*i*) *Intellectual.*—Promotion of the spirit of inquiry and reasoning as against the habit of accepting opinion on trust and out of uncritical reverence for established authority; and assertion of the importance of free human striving.

(*ii*) *Life-supporting.*—The countless varieties of industrial inventions including all distance-abolishing, time-saving, labour-saving and cost-saving devices, feats of engineering, agricultural recipes, medical and surgical appliances, mechanical gadgets for comfort and convenience; indeed all the immeasurable commercial output of science and technology excepting armaments.

(*iii*) *Destructive.*—Military material of all kinds.

What has human nature made of these?

(*i*) *Unfaith.*—The habit of demanding objective proof has made men forgetful of the possibility of there being in existence a something which, while operating in their lives as truly and as effectively as anything visible and tangible, is not to be captured and treated by the apparatus and methods which have achieved such impressive successes in the physical world. So has grown a general scepticism in regard to things of the spirit and an insensibility to values other than those of utility and comfort in the world known to men. What man is able to explain is the true and what he can enjoy is the good. His intelligence and his sensation are to be the sole measurers of reality and right.

(*ii*) *Acquisitiveness.*—The industrial achievements of science have converted the whole of the varied world into a single market-place, and naked mercantilism has become its working faith. With the multiplication of inventions and concoctions multiply our tastes and cravings; and the din and bustle of the market-

fair continues to grow. What matters is profit and possession, no matter how to be acquired and at whose cost. A ruthless individualism is the rule for men and countries.

(*iii*) *Aggressiveness.*—"Power corrupts" said the great historian Acton. So does the consciousness of power born of the possession of well-equipped armies. Goaded on one side by the urgencies of a standard of living kept continually rising by the progress of science and technology, and tempted on the other side by the accumulating strength of new and more new weapons of war, how could nations restrain the impulse to fly at one another? Power is to be dreaded because of the temptation inherent in it. It always keeps crying to be used; and only those who have for long trained themselves in patience and self-restraint can withstand the temptation. But where is the impulsion for restraint to-day?

So has grown our world-welter. Wars there were in the ancient world; but they were born of the dynastic feuds and personal vanities of kings, not of the land-hunger and oil-thirst of whole peoples. The wars of old limited their operations to the chosen battle-fields and did not upset the economic life of whole communities or ruin the peace of the civil populations in town and village. There was some law of humanity and of honour controlling the soldier of the bygone age; his successor of to-day knows no such inhibitions. The difference in causation and in method between old-world wars and ours is the contribution—surely the undesigned contribution—of science to human affairs. Scepticism as to the reality of a principle beyond the analysable and the measurable world, mercantilism as the chief inspiration in human relations, and militarism as the sanction of claims of one against another—is it for these that science planned and worked?

Science has put idealism to flight. Mastery of the definite has eclipsed the sense of the undefined. We have left to ourselves no point of reference outside the reach of our own arm for the judging of the true and the good. Is this attitude of self-sufficiency in man scientific? Is it unscientific to postulate the existence of an entity outside Man's own self and Nature to be reckoned with—a Third Partner in the business of life, so to say?

If the old faith in the omnipotence of fate was a superstition, the new faith in the omnicompetence of human intelligence is no less so. If the old surrender to the doctrine of pre-destination was a superstition, the new confidence in the illimitability of man's conquests is no less so. And science which demolished the old superstitions should be as eager to detect and destroy the new ones. The first need of to-day is the correction of the fundamental attitude of the civilised man towards life and its concerns. The need is for that salutary spirit of humility which must come from the recognition of the possibility of a hypothesis of an immeasurable reality—a reality to be "glimpsed"—and perhaps not more than glimpsed—by what one might call the Sixth Sense,—the sense irrelevant to

objects of the physical world, the sense of what truth-seekers of another order have called the soul or the spirit. Having demonstrated the amplitude of man's latent powers, science has now got to make it clear that she has found nothing to warrant a denial of the existence, outside the realm of the physical, of a something which is ceaselessly at work,—through Nature and possibly through the instrumentality of Man himself,—to modify the operations of his power. The second half of the task of science remains to be taken in hand, and it is to help faith to find a place for herself in the life of the civilized man,—faith in the functioning of a Third Partner.

In this article, the word science has so far been used to denote exclusively the natural or physical or "exact" sciences. It is these sciences that have ruled our civilization for some decades now,—roughly since the invention of the steam engine and the railway more than a century ago. To complete the work they have accomplished on the intellectual and moral planes, they have need of the collaboration of sciences less exact—those called "social sciences"—and of non-sciences, too, which are no less valid registerings of the experiences of the human spirit in its quest after the true and the good,—those intimations of the deeper springs of life which come to us through poetry and music and the variegated story of the struggles of men and nations for improving themselves called history. Life, in all conscience, is the most serious business that man has to think of, and the veriest maximum of wisdom that he can possibly garner may not prove adequate for its purposes. But if that wisdom should be not less even by an iota than the maximum that our effort can make possible, we have need to attempt a correlation and synthesis of the fractions of knowledge and thought available from every conceivable department of the activity of man's intellect. Our attitude should be scientific; and the truly scientific attitude cannot deny recognition even to realms of being where one works by faith and faith alone. It is rational to argue that, in such realms of faith, there is always the possibility of illusion and hallucination and self-deception. Against these errors, we have some protection in the critical and checking apparatus furnished by one body of knowledge towards another. It is possible that even after all possible eliminations of error and illusion have been made by criticism, a residuum of error and illusion will remain. But that is a risk against which we are helpless and to which therefore we must prepare ourselves to be reconciled. In other words, a scientific consideration of the duty of man towards himself seems to suggest that he should learn not only to strive through a rational synthesis of knowledge to improve his condition, but also to bear manfully such failures or frustrations as all his reason and skill may not be able to avert. He needs a certain quality of resignation as much as he needs the will to constant effort. Paradoxical as it may seem, striving and resignation are both equally parts of wisdom.

Nature has implanted a paradox in the heart of man; and all conflicts in the world are its logical issue. He is both social and anti-social,—both self-centred and self-denying,—one moment obsessed with himself, another gazing at the stars and glad to

be absorbed into starlight. What science has done to him is to stimulate the egoistic in him to the neglect of the altruistic. It has tilted the balance of the soul. Restoration of the equilibrium is now the first need.

Many minds naturally have been at pains to make plans for the reconstruction of the world. These attempts have generally been in the direction of schemes for the combining of States into federations or unions. Some are suggesting an imperial federation under the hegemony of Britain, some a federation of the world under a Super-State charged with the office of securing peace and security to all nations under the sun. Various are the plans, and each has its own special recommendation. But the first stage of the approach to the problem should be through ethics and economics and not through politics. The police and the magistracy should follow, and not precede, legislation; and the legislation needed is in respect of the distribution of the goods that the world has to offer. Measuring the goods and creating the machinery for their distribution is the task of economics; and enunciating the principles of distribution is the task of ethics. Sir P. C. Ray, the doyen of Indian scientists, has spoken not only as the authentic voice of India, but also as a votary of equity and justice in world's affairs, in saying, in his letter to Sir Richard Gregory, President of the British Association, that "the question of scientific reconstruction of society on principles of freedom and justice for all should not have geographical limitations" and that "the problem of the freedom, progress and happiness of mankind is indivisible in the modern world".

A correct diagnosis is half the cure, and the first half. Sir P. C. Ray has laid the finger on the central plague-spot of the existing politico-economic structure of our civilization. The implications of his remonstrance are two: (*i*) Humans should all be treated as Humans,—not as Whites or Browns or Blacks; and (*ii*) as a corollary to this, conditions of good living should be secured to all alike. In the numerous schemes now being put forward for the reconstruction of the world, the people generally taken into account are those of the European or white races, or of States at present sovereign and self-governing. In a discussion of "equal living-space for all nations,"* for example, attention is confined to "the seventy-two self-governing States of the earth",—India and many other countries not being among them. Similarly Mr. Churchill has made it clear that the Atlantic Charter† (referred to by Sir P. C. Ray) is to apply only to "States and Nations of Europe now under Nazi yoke". As if the rest of mankind do not count! As if they have no grievances! As if their grievances and aspirations would not matter!

It is surely not being scientific to ignore an axiom; and the first axiom pertinent to world-planning is that the prime motive force of life is hunger; that hunger does not know black from brown and brown from white; that hunger unsatisfied is the sure beginning of insurrection. It is idle to contend that the non-white or the non-self-governing peoples of to-day are not within the pale of civilization or are on a lower

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* R R. Kuczynski (Oxford Pamphlet 8).

† The joint declaration of War Aims by the British Premier Winston Churchill and the American U. S. President F. D. Roosevelt on the 14th of August 1941.

level of it. If what is termed civilization is worth anything, they are all candidates for it. The example of the white and the self-governing is enough to convert the rest from potential into actual contestants for the world's goods. Unless the white and the self-governing are prepared to extirpate the coloured and the subjugated, they must be prepared for a conflict (as Sir P. S. Sivaswamy Aiyer pointed out the other day in a Madras speech)‡ between the "satisfied" and the "unsatisfied" of the earth, between the "haves" and the "have-nots". What then is the present planning to be for? For dispossessing a portion of the race? Then it can not possess even the merit of durability: No unscientific arrangement can stay long.

Conditions of good living are not easy to define; but they are understood easily enough even without a precise definition. The Atlantic Charter has compactly described them as "a *peace* which will afford to all nations the *means of dwelling in safety* within their own boundaries and which will afford assurance that all men in all lands may live out their lives in *freedom from fear and want.*" (Of course the word "all" in the quotation is to be taken as qualified by "white", "self-governing" and "European".) A little more in detail, the conditions are a sufficiency for all of living-space and of raw materials convertible, through money, into food and clothing and shelter and other necessaries of life; free markets; facilities for education and work and recreation; leisure to attend to the deeper longings of the mind and the spirit; sense of freedom; sense of individual worth and usefulness as a unit of the human race. Who is there that does not ask for these? Those who have no appetite for any of them to-day are not to be counted upon as likely to remain sluggish for all time. Good example will tell, even upon the Asiatic and the African; and if the European and the American do not want to have trouble to-morrow, they had better realize to-day once for all that the safest course for them is the course of righteousness—treating all humans alike. Equality—the heart-string of humanism and the vital sap of democracy—is not only a principle of justice, but also one of expediency in view of the certainty of the later uprising of those who are now left ignored because of their powerlessness to make themselves heard. If planning is not to be based upon this principle, the name proper to that proceeding would be a less innocent word. A preliminary question, then, to be answered by those who will have it in their power to give effect to any plan is this—whether they are prepared to regard all human beings as human beings and as entitled to look for equal treatment to the extent practicable in the future world-organization and whether they would observe equity in the distribution of what our common mother earth has to offer her children?

The need to set up an agreed international agency, to carry out an agreed programme of measures for world peace is self-evident. What are to be the items of the programme? Many lists have been drawn up—the so-called Atlantic Charter (cited below as A.C.) being one. And here is one offered from a somewhat different point of view:—

(1) *Living-space for all.*—This includes not only the surface area of the globe,

‡ The "*Hindu*", November 17, 1941.

but also the underground resources. The A.C. has recognized the principle that all territorial settlements should be in accordance with "the freely expressed wishes of the peoples concerned". America, by an Inter-American Conference (1936) declaration, has accepted the principle that all territorial conquests should be proscribed and that "no territorial changes resulting from the use of violence are to be recognised by any government". The question is one too complicated to be solved without reference to the local history and conditions of each area. An expert body of economists, demographers and other specialists will have to furnish the necessary advice. But the general principle is that each State or political community should have enough command of the earth's space to be able to find sufficient food and occupation for all its present population and also any increase forecast as likely on the basis of census statistics. An iniquitous distribution of the first gift of nature is the root-cause of all disturbances to the peace of the world; and no settlement can last which has left a sense of unfairness in the mind of any community or nation.

(2) *Democracy Everywhere.*—The A.C. promises to "respect the right of all peoples to choose the form of government under which they will live". But this is not necessarily upholding the cause of democracy. People in the Totalitarian States of to-day are not free really to exercise their choice. It is also not unlikely that there may be a large section of the public in a country habituated to taking short-range views in preference to long-range views under the stress of war conditions; and to such people a dictatorship may appear a surer means of ensuring efficient government. Is it not the boast of the bureaucracy that its administration is more "efficient" than a democracy's can ever be? Dictatorship, oligarchy, bureaucracy, indeed any form of government by a body which is not open to the scrutiny and control of the citizen-body may be right in claiming to be more capable of efficiency than a democracy; but it is a potential exploitation-field for capitalists and armament-makers and manufacturers and money-grubbers of all kinds, and thus a breeding ground for war-microbes. It is the public at large that suffers the worst when a war is on; and therefore it is the general public that is the most interested in preventing bellicosity. The slogan during the last war was about "making the world safe for democracy". But our experience since then has shown that it is democracy that can make the world safe for humanity. To make this claim for democracy is not to count it infallible. It has weak spots like all other human institutions; and the ways of strengthening it are a big enough subject to merit a separate study. But no democracy can feel confidence about its own safety so long as there is left an autocratic or oligarchic or totalitarian or otherwise "irresponsible" government anywhere in the world; for these are the potential breeders of aggression and imperialism. No household can go to sleep in a sense of safety when there is a plague-infected street in the neighbourhood, or the presence of burglars is suspected about the town. To establish democracy everywhere is the only true way of making the world safe for democracy. But it must be admitted that many parts of the world are at the moment not fully in a condition to adopt a democratic regime: and they need time, and perhaps assistance, to prepare themselves for it. When, however, it is once definitely decided that democracy—with State socialism in some form as its programme—is to be the political ideal for all, the question of arranging help to the less prepared will be merely a matter of devising machinery. There is a precedent, but certainly no example, in the Mandates system of the League of Nations. Speaking from the standpoint of ideal perfection, one must admit that no country in the world has yet been able to reach the peak in the democratic enterprise, and that even the most advanced has still a long distance to cover. That being so, it is for no one now to question another's fitness. There is no question of racial or geographical or linguistic or other peculiarity

intrinsic to democracy; and its essential principle is one of universal human nature. All members of the human family are educable to it; and those advanced should, to be consistent with their own ideal, look upon the education of others for democracy as "a sacred trust of civilization".

(3) *Limitation of Aramaments.*—The A.C. approves of the ideal of "the abandonment of the use of force" and promises support to all "practicable measures which will lighten for peace-loving peoples the crushing burden of armament". The covenant of the League also (Art. 8) contemplated the reduction of armaments. But the League was singularly ineffective there. The control to be exercised should be not merely in respect of munitions factories, but also in respect of their laboratories. There is a very special responsibility for men of science here. They must willingly submit their researches likely to be useful for military purposes to be examined, and their reports of results to be controlled, by an international agency. When knowledge of a new death-dealing invention is made accessible to all countries alike, their rivalries in military equipment will in effect have been reduced by half.

(4) *Economic Development for All.*—Each State should be helped to ensure to all its subjects a minimal standard of earning and welfare; for, a full-fed stomach is the surest guarantor of peace. It is of course difficult to fix the datum line. Economists must help us here. It is perhaps inevitable that the contents of the minimum must vary from country to country; also that the minimum should keep rising to a higher point from year to year. The appetite grows with what it feeds upon; and the State which is indifferent or inefficient in satisfying it is a source of danger not only to itself, but also to the international body politic. In this task, therefore, a State would be entitled to look for international co-operation and help. The help should take these forms:—

(i) An international bank or financing institution to lend money for development purposes, such loans involving no political or military or trading obligations towards any one country or State;

(ii) Supply of technical knowledge and skill and industrial machinery;

(iii) Open markets: The A.C. is grand on this point. It would "further the enjoyment by all States, great or small, victor or vanquished, of access on equal terms to trade and to the raw materials of the world which are needed for their economic prosperity". This must involve a revision of the system of tariffs, and economists should be our advisers.

It should be made both possible and obligatory for each and every State to so manage and use its resources that, while individual initiative and enterprise are encouraged, there will be no monopolistic clot in the economic life of the community and so that there will be an equitable distribution of the means of welfare throughout all classes of the population.

The doctrine of economic self-sufficiency as the goal for a country has been blamed as the inspirer of bellicose designs. That doctrine, when it assumes an extreme form, is undoubtedly unsound economics. A country's economic boundaries cannot always coincide with its geographical boundaries. Its needs are larger than its resources. Its attempts at self-sufficiency must therefore sometimes involve both waste of its own material and disturbance to some other country's prosperity. But what about economic aggrandizement which would keep other countries primitive and undeveloped so that they may remain available for exploitation as producers of raw-material and markets for finished goods? In truth, the less developed country is the bone that provokes contention among the better developed.

The A.C. is indeed gratifyingly adequate on the question of international co-operation

towards economic and social improvements. It desires "to bring about the fullest collaboration between *all* nations in the economic field, with the object of securing *for all* improved labour standards, economic advancement and social security".

A reconstructed League of Nations—reconstructed radically so that it could find more strength in its arms and more courage in its heart,—seems to be the agency for executing a programme like the one just sketched. Experience has shown us the deficiencies in its present structure and sanctions. The League should be made to include every country of the world in its membership and should be enabled to organize effective action against the recalcitrant. Developing the existing organization seems clearly a more advantageous course than trying to set up a Federal World State made up of the funded part-sovereignties of component States. The idea of such a Super-State is new and not easy to the international public; and they would naturally require time to grow familiar with it and appreciate its appeal. The way to it may be through a more vigorous working of the League. The League, faithfully supported, may itself evolve into a federal world-government in course of time.

But let us be warned never to expect to find an earthly paradise about ourselves. With the best League or the strongest World-State,—the British leading it or the Americans helping it or the whole host of the saints and sages of history inspiring and guiding it,—with all its most earnest care and its most devoted exertion,—man may still find some things not according to plan, some forces not yet amenable to reason. To be prepared for such contrarious contingencies should be part of his self-discipline.

Arnold Toynbee, one of the truest of friends the common man ever had anywhere and one gifted with a sage's insight into the problems of our age, wrote these words which, after sixty years, have lost none of their appositeness:—

> "Men's rights will clash, and the reconciliation must come through a higher gospel than the gospel of rights,—the gospel of duty; that gospel which MAZZINI lived to proclaim; for not Adam Smith, not Carlyle, great as he was, but MAZZINI is the true teacher of our age ... MAZZINI was a democrat who spent his life in struggling to free his country; but he believed in liberty not as an end but as a means—a means to a purer and nobler life for the whole people. The time has come to preach this gospel."

With our best effort and best propitiation, the Third Partner,—he who puts in the element of uncertainty into our calculations,—may choose to go his own way and not ours; and then our refuge must be in a sane philosophy of cheerful fortitude and renewed endeavour.

> "To live, and bear; to hope till hope creates
> From its own wreck the thing it contemplates;
> Neither to change, nor falter, nor repent."

Conditions of peace are only partly in man's environment; partly they are within himself. If the world must give him a little, he must also be prepared to go without a little. An arduous and persistent fight for rights has given the modern man a fretful habit of mind; it has put the soul in an attitude of perpetual rebellion. That is as grave a menace to the world's peace as the external injustices he complains of. After

all, a certain degree of forbearance and resilience are indispensable if we should keep a proper sense of values and remain friends with our fellow-men. The promoting of such mental equipose and will to peace is no small part of the work for a better world-order. And that is the mission of great literature and great art. The League of Nations was most happily inspired when it set up the Committee for Intellectual Co-operation. An agency like it should,—by means of translations of great books, lecture tours of leaders of thought, local gatherings of public-spirited men and women for study and discussion,—help to bring about a better knowledge between the countries of the world of their respective cultures and civilizations, their attitudes towards life and their habits of thought. Understanding so promoted is bound to prove a strong asset to the cause of peace. Men will not then be so ready to take umbrage and fly to arms. And minds so liberated, having horizons so broadened, may be trusted to throw their weight on the side of sanity and good sense when the jingo is abroad.

The problem of permanent world-peace has for long engaged the minds of philosophers and poets. Kant dreamt of a confederation of States, and Tennyson sang for a warless world—

> When the war-drum throbbed no longer, and the battle-flags were furl'd
> In the Parliament of Man, the Federation of the World.

But scientists do not seem to be so sanguine. Some of them, at any rate, see an insurmountable obstacle in the very constitution of our hormones. Seeds of prejudice and jealousy are inextricably fixed there, and who can cast them out? The Vedic seers have taken the view that man is a mixture of good and evil, and that the disciplines of social duty and religious devotion as well as intellectual and æsthetic culture should serve to handicap the brute and give advantage to the angel in him. The sober statesman is he who, while being glad to deal with all as if they were angels, would none the less keep himself prepared to meet them even if all turned out brutes. Let us work for world-peace: but let us not behave as though it were already a fact.

In all our attempts to establish a new world-order, we should take care to keep clear of one delusion if we would avoid futility and vexation. It is given to no scientist, and to no statesman or economist or social reformer either, to turn this world of mortal men into anything to compare with the paradise of which poets and prophets of religion have spoken. The ideal portrayed by the poet and the prophet is of use but as a pointer and an incentive to effort; the disciplines which its acceptance must impose on us would be of value; the strength resulting from such disciplines is bound to be valuable: approximations towards the ideal as a result of this growth of strength must also follow in the train. Ideal therefore there must be, and effort in its direction; but with that effort the courage to face a failure and the faith for renewed effort. Man's practical wisdom can never prove sufficient for the visions of felicity granted to him. No poet's verbal ingenuity was ever equal to the nuances of his imagination; no painter's brush ever fine enough for the shades of the picture his mind has visualized. There is always an inevitable hiatus between the ideal in the mind and the accomplishment of the hand.

Such is the intractability of the material upon which the statesman (like the artist) has to work. Man's progress therefore cannot be an uninterrupted and continuous and unlimited increase of strength and felicity. It is rather the securing of the recurrence of flood-tides. Have we a sufficiency of vital energy in ourselves to feel sure of its rise after a fall of the wave? Is there sap enough in the root for the plant to survive from autumn to spring? Evaporation of water being unavoidable, is there a goodly stock in our reservoir to outlast the summer? We are then on the road of progress. So it is in a modest and chastened attitude that we should take up the task of re-building our civilization.

D. V. G.

HAFFKINE INSTITUTE

THE Annual Report of the Institute for the year 1939, records an impressive advance in all directions, particularly in the field of research. It is a matter of supreme gratification and an example worthy of emulation, that the Institute, which is burdened with the principal routine of providing large quantities of plague prophylactic and other vaccines and of carrying out diagnostic work for hospitals and private practitioners, should take upon itself the responsibility of organising a research section and achieve results of great value. These activities were generously supported by a grant of Rs. 50,000 from the Indian Research Fund Association and by the endowment of two research scholarships by the Lady Tata Memorial Trust.

Special attention should be invited to the syntheses of a series of new sulphonamide compounds undertaken by Mr. K. Ganapathi, one of the Lady Tata Scholars, in connection with chemotherapy of plague. The Director remarks, "Researches into the chemotherapy of plague have yielded very important results and beget the hope that an effective remedy for bubonic plague is within sight."

Reporting on the clinical results of these drugs, Col. Sokhey writes, "In spite of the inadequate dosage, the curative results are remarkable. Further, these sulphonamide drugs have many advantages over the serum. The drugs are administered by the mouth, are comparatively cheap to make and do not deteriorate on storage. While anti-plague serum is expensive to produce, has to be administered by the intravenous route and deteriorates very rapidly unless stored in refrigerated space. In India where plague is now almost entirely a rural problem, the sulphonamide drugs have everything in their favour. Further, and this is more important, the same drugs are equally effective in a number of other infections, such as pneumonia and blood poisoning."

Col. Sokhey continues "Synthetic organic chemistry has, during recent years, yielded compounds of the greatest value to medicine. It is certain that this particular branch of research is destined to become even more important in the near future, particularly the chemotherapy of bacterial diseases. There is a great deal of chemical talent available in India, but chemists working in isolation by themselves cannot achieve much. For worthwhile work intimate collaboration of chemists, bacteriologists and pharmacologists is essential. The Haffkine Institute is admirably suited as centre for such collaboration. It would be a great gain if a permanent department of chemotherapy is organised at the Institute." We fervently hope that Col. Sokhey's idea of a permanent department of chemotherapy will soon be realised.

X-RAYS, CRYSTALS AND THE INFRA-RED SPECTRUM

BY

SIR C. V. RAMAN

THE *Proceedings of the Indian Academy of Sciences* for October 1941 is devoted to a symposium of fifteen papers dealing with the interaction between X-rays and crystals which results in an excitation of the infra-red vibrations in the solid and a consequent reflection of the X-rays with change of frequency. This phenomenon was first described in an article in *Current Science* for April 1940 by the present writer and Dr. P. Nilakantan, and was further reported on in the issue of *Current Science* for May 1941. The symposium now published is a comprehensive account of the whole subject and shows that the new facts and ideas put forward in April 1940 were solidly based on reality. The theory given in broad outline in earlier publications is now fully developed and finds striking experimental confirmation in various directions.

The phenomena of the scattering of light in crystals show clearly that the interactions between matter and radiation which involve a change of frequency in the latter can only be successfully interpreted on the basis of quantum mechanics. That a similar situation also arises in regard to X-rays becomes evident when it is recalled that the secondary X-radiation from a vibrating atom in a crystal appears, in part, with a change of frequency. Any coherent vibration of the atoms in a crystal with a specifiable frequency is therefore capable of giving rise to radiations of altered frequency which can interfere with each other and give rise to observable effects. The change of frequency involves an exchange of energy between the crystal and the electromagnetic field, and this can only occur in complete quanta or units of the particular vibration frequency. The interferences which arise may therefore be regarded as due to an inelastic collision of the X-ray photons with the crystal lattice. They appear as geometric reflections of the X-rays by the lattice planes of the crystal, analogous to, but quite distinct from, the reflections of the usual kind involving no change of frequency.

The vibrations possible in a crystal lattice may be classified under two heads. The first kind are of the macroscopic or elastic type which may be described without specific reference to the atomic architecture of the solid. They present a continuous spectrum of frequencies, and when the limiting wave-length is chosen sufficiently large, their aggregate energy is small, while the energy of a particular frequency of vibration is quite negligible. In these circumstances and in view of the arbitrary wave-length and orientation of the elastic vibrations, their effect on the X-ray propagation is very small, appearing as a diffuse scattering. Of much greater importance from the X-ray point of view are the atomic or infra-red vibrations which involve a time-periodic variation of the fine structure of the solid. These have higher frequencies than the elastic vibrations and appear as monochromatic lines in the infra-red spectrum of the solid. The nature of these vibrations is very fully discussed in the opening paper of the symposium. It is shown that the observed monochromatism of the infra-red vibrations indicates that they take place in a completely ordered fashion, the frequency, amplitude and phase of the vibrations being identical over extended domains in the crystal. The result of such synchronism is that the associated secondary X-radiations have coherent phase-relationships and give rise to X-ray reflections of observable intensity in geometrically specifiable directions. (See Fig. 1.)

The second paper of the symposium is devoted to a mathematical formulation of the theory. The classical and quantum reflections are considered together, as it appears from the theory that they stand in close relation with each other. The secondary radiations from the vibrating atoms in a crystal are analysed, and expressions are derived from the static and dynamic structure factors. In the limiting case when the lattice vibrations are in perfect synchronism in all the cells of the crystal, the intensity problem admits of a complete solution, as the vibration energy of each lattice cell may be then taken as one quantum of the particular frequency. The calculation shows that the quantum X-ray reflections have

an appreciable intensity, smaller than but not negligibly small in comparison with, the intensity of the classical reflections.

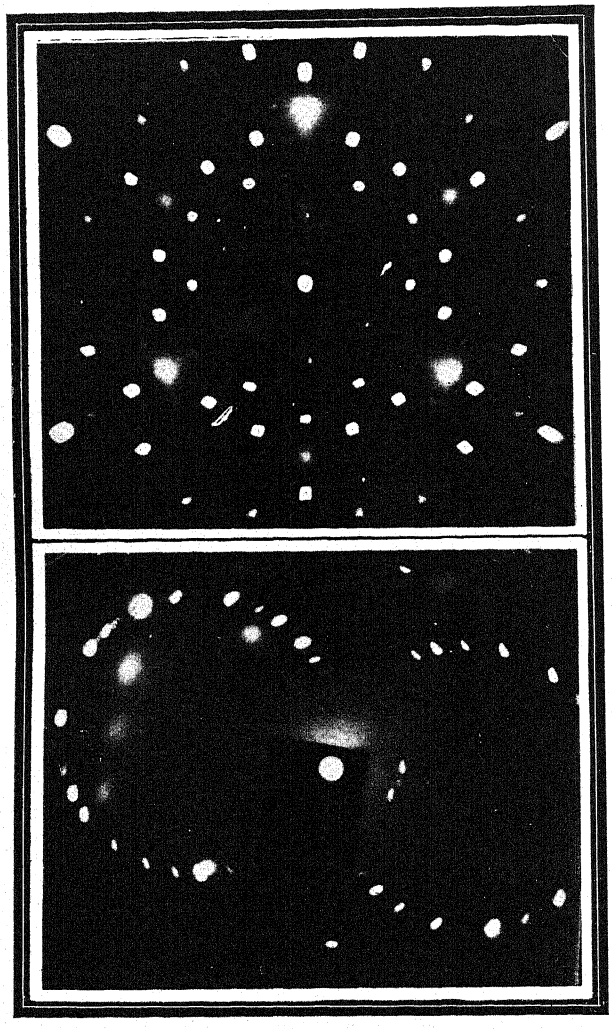

FIG. 1

Quantum X-ray Reflections in Benzil Crystals

The third paper in the symposium presents the experimental evidence in a particular case, *viz.*, that of diamond, quantitatively confirming the theory. Particularly noteworthy are the photographs of the (111) quantum reflections of diamond taken with a very fine beam of X-rays and very prolonged exposures and reproduced as Fig. 6 in Plate XVIII accompanying the paper. The reflections appear as exceedingly fine lines in the record, indeed as sharp as they would be if they were true geometric or specular reflections without any angular spread. These two photographs alone would be sufficient to show that the various alternative theories of the phenomenon which have been recently put forward in the X-ray literature are untenable. All these theories indicate a broad or diffuse scattering, instead of a sharply defined geometric reflection as is actually observed in the case of diamond.

Of the remaining twelve papers in the symposium, no fewer than six are contributed by Dr. C. S. Venkateswaran. Particularly valuable are his studies of the intensity of the quantum X-ray reflections at liquid air temperatures by a series of crystals, *viz.*, carborundum, rock-salt, sodium nitrate and penta-erythritol. The experimental data are in complete accord with the theoretical formulæ and indicate that such X-ray studies with crystals open a new avenue of approach to infra-red spectroscopy. The case of metals dealt with by Mr. Bisheswar Dayal in another paper in the symposium is an instance where such an approach might prove of great importance.

An important result indicated by the quantum theory of X-ray reflection is that in particular cases, the classical reflections may vanish while the quantum reflections persist, or *vice versa*. In a remarkable paper appearing in the symposium, Mr. Rama Pisharoty calculates the intensities of the (222) and (662) quantum reflections by diamond and shows that they are in agreement with the intensities as actually observed, thereby indicating that these so-called "forbidden" reflections which should not appear on the classical theory are in reality quantum reflections. Another remarkable case of the kind is furnished by the ratio of the intensities of the (111) and (222) reflections by the lattice planes in rock-salt. The theoretical calculations by Dr. Venkateswaran indicate, in striking agreement with observation, that this ratio is far smaller for the quantum reflections than for the classical reflections.

Four of the papers in the symposium deal with the case of organic crystals, *e.g.*, naphthalene, benzophenone, hexamethylene-tetramine and benzil. Fig. 1 above is

reproduced from the plate accompanying Mr. R. V. Subramanyam's paper on benzil. In the case of aromatic compounds, the infra-red vibrations with which we are principally concerned are those of relatively low frequency involving rotational or translational movements of the aromatic rings. It is evident that the crystal planes parallel to the aromatic rings would be strongly affected by such movements and would therefore give intense quantum reflections, while the lattice planes parallel to the rings would be unaffected by such movements and would therefore fail to give the quantum reflections. This indication of theory is strikingly confirmed by observation. Indeed in the case of benzil, the intense quantum reflections observed immediately indicate the number, orientation and azimuth of the benzil molecules present in each lattice cell.

CAMOUFLAGE PAINTS

BY

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SINCE the World War of 1914–18 the word camouflage, originally a French word, has been adopted throughout the world to denote a particular type of military deception in which paints and artists play the major role. In the unrestricted sense the word may be applied to any device which is calculated to mislead the enemy. Such general camouflage has been practised by belligerent nations throughout history. The Wooden Horse of Troy, the Moving Forest in Shakespeare's Macbeth and the incalculable Shivaji's escape in a basket of sweetmeat under the very nose of Aurangzeb are some of the popular examples of camouflage in the general sense. Napoleon is known to have made extensive use of camouflage in his campaigns, and it will be readily understood that in war, in which everything is considered to be fair, military deception must occur to generals and soldiers alike as almost a first principle.

As in all great things, man learnt the broad principles of this art of military camouflage from nature. She is the effortless master camoufleur who resorts to camouflage in order to preserve her species. Examples of nature's camouflage extend from the tropical vegetation, through the desert sand, to the bare winter twigs of the temperate zone and the snows of the Polar regions, and these are too many and well known to mention. The principle followed by nature is to produce species which in colour and form are more or less indistinguishable from their surroundings in order to avoid easy detection by enemies. Much of the military camouflage follows exactly the same principle. Gun positions, machine gun emplacements, observation posts, aerodromes, industrial buildings and large installations have to elude detection by the searching eye of the enemy from the air, and the means is camouflage which renders them indistinguishable from the general surroundings. Ships have to mislead submarine commanders as to their exact course, and "dazzle painting"—a form of camouflage in paints—was one of the devices adopted during the last Great War. Even the colours of the field uniforms are a form of camouflage.

Camouflage as an established military and naval practice originated during the Great War of 1914–18. The French gave the lead and the British and the other belligerent nations followed and developed the principle and practice rapidly in all possible spheres. As the aerial eye became ubiquitous and the aerial attack the most potent form of warfare, the necessity for reasonably effective camouflage became one of the fundamental concerns of Governments and fighting forces.

In this article it is proposed to deal with the technical aspects of camouflage paints which are being used in colossal quantities in all belligerent countries. Extensive demands have arisen in this country and paint manufacturers in India are being required to supply large quantities at short notice. These demands are likely to increase as the war situation develops in the Middle and

Far East. Although the special characteristics of camouflage paints were generally known, the paint manufacturers in India were not actually concerned in their manufacture until the war demands arose.

Whereas camouflage painting started as an art, both paints and schemes of painting are now based on definite scientific principles. The effective application of these scientific principles in devising schemes of painting requires the services of biologists, psychologists, artists and service men who have made a special study of the subject of camouflage. Schemes considered satisfactory during 1914–18 have in many instances been shown to be ineffective under the conditions of the present war, and last year *Nature* published strong criticisms of many of the camouflage efforts in England and attributed the unsatisfactory state of affairs to Government's failure to utilise the services of trained biologists and psychologists. Indeed, the camouflage problems under the present conditions of warfare have become highly complicated, and reasonable success can only be expected if the services of biologists and psychologists as well as of artists and service men are harnessed to the work. It is obvious that an intimate knowledge of natural and physical sciences alone can result in forming perfect camouflage effect. By the aid of infra-red photography it is possible to distinguish between opaque mineral colours and organic pigments transparent to these radiations. A reconnoitring aeroplane with a photographer provided with infra-red ray photographic equipment can thus easily detect camouflage in mineral colours against the natural backgrounds of trees, foliage, flowers, etc. It is possible to devise ways and means which will obviate this drawback, but the financial aspect has to be taken into account.

The colours of camouflage paints have been standardised, and as used in the British Empire, these now number seventeen. The colours are all dull and range from different shades of dull brown and red, through dull greys and greens, to black.

One of the most important characteristics of camouflage paints is that they shall dry to a perfectly matt surface. Even a trace of gloss on a painted surface will cause sufficient reflection of light to make objects look prominent from the air. At no angle of observation must there be the slightest suggestion of reflection, and this property must be maintained when the surface becomes wet by rain or dew. The question of fastness of colour is also a very important one, since premature fading may so alter the colour scheme as to render camouflage completely ineffective. This consideration imposes a definite restriction as to the range of pigments that can be used in the camouflage paints. Camouflage is not concerned with the protection of structures from the effects of atmospheric conditions and in that sense durability of the paint is not of importance. On the other hand, from the camouflage point of view a reasonable degree of durability is necessary, and this point has to be borne in mind particularly because the average matt paint shows poor durability when used for outside work. The formulation should, therefore, aim at combining perfect mattness with adequate durability.

In the evolution of camouflage paints many different possibilities, such as flat oil paints, oil-bound distempers, bitumen emulsion paints, wax paints, lanoline emulsion paints, silicate paints and cement paints, were investigated. Of these, three types that have been accepted as standards are flat oil paints, oil-bound distempers and bitumen emulsion paints. In India developments so far have been in the direction of flat oil paints, but the possibilities of bitumen emulsion paints are being investigated.

Camouflage paints are made in both gritty and non-gritty forms. The former is specially suitable for roofs and dries with an uneven surface which counteracts any tendency on the part of rain or dew deposition to reflect light. It is obtained by adding a suitable proportion of a coarse extender to the general formulation for the non-gritty paint. The proportions may be 50 lbs. of the coarse extender to 100 lbs. of non-gritty paint with an allowance for additional medium to ensure correct consistency. The gritty material must be non-reflective, and among those considered to be suitable for the purpose may be mentioned silica, slate powder and pumice powder passing through 40 mesh but retained on 80.

Of the possible white base pigments available for the formulation of camouflage paints, lithopone is acknowledged to be the most suitable, although in ordinary paint

practice lithopone is rarely used for exterior work. The other white pigments, such as zinc oxide, white lead, titanium dioxide, etc., show certain disadvantages, but so far as India is concerned, the supremacy of lithopone is substantially compromised by the fact that this pigment is not manufactured in the country and there has for some time been a definite shortage of the material in the Indian paint industry. Zinc oxide, on the other hand, is manufactured in India, and although owing to the limited capacity of the only one existing factory and difficulties of obtaining the metal, the issue of this pigment is being controlled during the war, it is available against Government orders for paints and consequently available for making camouflage paints. It is to be presumed, therefore, that much of the recent efforts at making camouflage paints in this country has been on the basis of zinc oxide, and unless adequate facilities can be given by Government for continued importation of lithopone, zinc oxide may have to be invariably used by paint firms in India in place of lithopone.

The only red pigments permitted in camouflage paints is red oxide of iron—natural or manufactured—and red ochres. The use of organic dyestuffs is prohibited. The yellow pigments are confined to yellow ochres and chemically prepared hydrated oxides of iron. Lead chromes, zinc chromes and organic yellow colours are prohibited. Different shades of natural and synthetic oxides and hydroxides of iron can be mixed in any proportions to obtain the desired effect. Red oxides and yellow ochres are abundantly available in India.

The most suitable green pigments for camouflage paints are chromium oxide and pigment green B, which is an insoluble dyestuff. These are not ordinarily available in India, and paint manufacturers have presumably to resort to mixtures of Prussian blue and yellow ochre or of ultramarine blue and yellow ochre. These mixtures have limitations from the camouflage point of view but are unavoidable under the present conditions.

Raw and burnt umbers can safely be used for tinting purposes. The permissible black pigments include black oxide of iron, mineral black, carbon black and lamp black. The umbers and various black pigments are stocked by paint manufacturers in India.

Apart from whiting and gypsum which are not favoured for camouflage paints, the majority of the usual extenders are considered suitable. Owing to their flatting properties, barytes and silica are largely used in these paints, and possibly the paint manufacturers in India rely mainly on barytes. China clay, French chalk, asbestine and bentonite may be used in small quantities with advantage, as these reduce the setting tendency of pigments. Owing to the fact that a considerable time may elapse between supply and use and in view of the unusual conditions under which these paints may have to be used, it is very important that manufacturers' formulations should provide adequately against the hard settling of pigment. The tendency to settle may also be checked by using heavy-body litho oil in the medium or by using a small amount of a dispersing agent, such as aluminium stearate or aluminium palmitate.

As an illustration of the composition employed, a few representative formulæ employed in trade are given below:

1. Lighter Colours

Pigment	70%
Non-volatile medium ..	10%
Volatile thinner ..	20%
Composition of pigment:	
Zinc oxide or lithopone ..	30%
Tinters	10%
Extenders and argillaceous matter	60%

2. Deeper Colours

Pigment	70%
Non-volatile medium ..	10%
Volatile thinner ..	20%
Composition of pigment:	
Zinc oxide or lithopone ..	20%
Tinters	20%
Extenders and argillaceous matter	60%

3. Red Oxide Colours

Pigment	75%
Non-volatile medium ..	10%
Volatile thinner ..	15%
Composition of pigment:	
Red oxide with other tinters if necessary	66%
Extenders and argillaceous matter	34%

There are many ways open to manufacturers to secure a perfectly matt surface in paints, and the principles involved are well known to them, since the production of matt paints for interior decoration is a common necessity even under ordinary conditions. The same principles are applied with suitable modifications to the manufacture of camouflage paints, but as already mentioned, a certain standard of durability under outdoor conditions, which is not necessary in ordinary matt paints intended for interior use, has to be ensured. A matt surface in a paint is governed by several factors which include the following:

Character and proportion of non-volatile medium.

Proportion of solvent.

Character and proportion of pigment.

A high pigment content is unavoidable in camouflage paints. Some pigments are more useful in producing a matt surface than others. In the case of flat oil paints which represent the camouflage paints made in this country, the non-volatile medium consists of linseed oil and/or certain types of varnishes, and the thinner is usually white spirit.

It has been mentioned earlier that oil-bound distempers can be used for camouflage purposes, although it is doubtful whether any of the paint firms in India has offered this type of material against demands for camouflage paints. Oil-bound distempers are essentially pigmented oil-in-water emulsion with glue or casein, or a mixture of the two added to the composition. The same restrictions regarding the choice of pigments as have been mentioned above apply to oil-bound distempers intended for camouflage purposes. The oily portion generally consists of a suitable linseed oil varnish containing natural or synthetic resin.

Bitumen emulsion paints for camouflage purposes are an extension of the principle underlying the production of bitumen emulsion as a road dressing material. Bitumen and water together with emulsifying and stabilising agents are the sole ingredients of bitumen emulsion. In bitumen emulsion paints, the proportion of bitumen has of necessity to be comparatively small, since the colour of the added pigments should not be materially affected. As these paints are also required in the standard camouflage shades, the formulation of pigments is generally similar to that adopted in the case of flat oil paints. Bitumen emulsion paints are particularly useful for asphalted surfaces, such as roads and bitumen roofing, as oil paints are not practicable on such surfaces owing to the bleeding effect. These paints are also supplied in gritty and non-gritty types. Attempts are being made to develop this type of camouflage paints in India, but it is unlikely that any large supply has actually been made yet.

From the foregoing description of the composition and characteristics of camouflage flat oil paints, it is clear that tests should be of a thorough character and must include the following points:

1. Complete chemical analysis to show the proportions of pigment, non-volatile medium and thinner and the detailed composition of pigment.
2. Physical tests to ascertain the time of drying, and nature of film on steel, concrete, wood, etc. (finish, hardness, opacity, complete freedom from gloss at all angles, etc.).
3. Fadeometer test to ascertain the fastness of colour.
4. Accelerated weathering test to ascertain the durability of paint.
5. Storage test to ascertain the keeping property of paint.

The expenditure involved in camouflage paints is very large indeed, and the effects of using unsuitable paints can be disastrous. It is, therefore, of the utmost importance to both suppliers and consumers that due care is taken in matters of manufacture and test.

A FRESH CYCLE OF THE DESERT LOCUST IN INDIA

BY

HEM SINGH PRUTHI

(Imperial Entomologist, I/C Locust Warning Organization, Government of India)

INTRODUCTION

BEFORE describing the events, associated with the initiation of a fresh locust cycle in India in the summer of 1940, a brief account of the history of the previous locust visitations and main features in locust biology should be of interest to the readers of *Current Science*. There are several species of locusts found in India, but of these, the desert locust, *Schistocerca gregaria* Forsk., is the most important. India has been, from times immemorial, subject to periodical visitations of locust swarms. In Sanskrit literature of the third or fourth century there is a mention of locust menace being one of the most serious calamities that cultivators had to face. Comparatively authentic records of locust visitation are however available only since the beginning of the nineteenth century and according to Cotes (1891) outbreaks occurred in 1812, 1821, 1834, 1843, 1863, 1869, 1878 and 1889. There was another cycle in 1896–97 and in the present century there have been serious invasions of the locust in 1901–03, 1906–07, 1912–15 and 1926–31. Thus there is a certain amount of periodicity in locust outbreaks when swarms appear and cause incalculable damage and destruction to crops, resulting sometimes in severe famines. Due to lack of fodder and pasture, there is heavy mortality among cattle, goats and sheep and sometimes people have to quit their homes in search of livelihood elsewhere. A moderate estimate of damage caused to crops alone during the last cycle (1926–31) was about 2 crores of rupees. Locusts usually remain active for several years in succession, ranging from 3–8 years. Generally their depredations are confined to north-western India but in some years, as during the last invasion of 1926–31, the swarms spread as far as Bengal and Assam in the east, and Madras in the south.

The outbreak areas of locust swarms where the desert locust remains and breeds permanently, lie in a vast desert tract, extending from Rajputana to the west coast of Africa (Text-Fig. 1). Investigations carried out for 8–9 years (1931–39) have shown that in India, permanent breeding grounds of this locust are in the desert

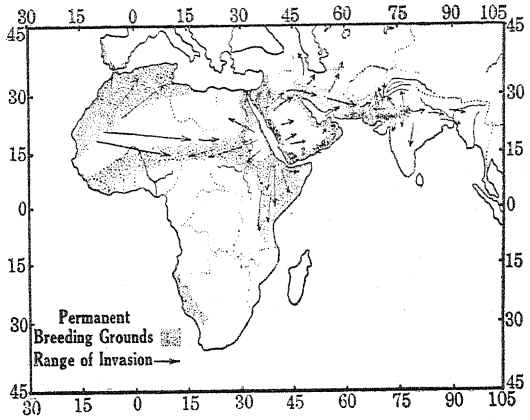

FIG. 1

Permanent breeding grounds of the Desert Locust and range of its invasion

regions of Rajputana, Sind, certain areas of Khairpur and Bhawalpur States and the coastal area of Lasbela and some parts of Kalat State in Baluchistan. These otherwise dry and desert tracts (Text-Fig. 2) become

FIG. 2

Pasni Reks, a desert area in South Baluchistan, where an important out-post of the Locust Warning Organization is situated

green with mostly wild vegetation after rainfall (Text-Fig. 3) and support locust breeding. Generally locust population is not heavy and cultivators and general public are hardly aware of it. When thus scattered about and rather inactive in movements, the locusts are said to be in the solitary phase. However, if the rainfall is abundant in the permanent breeding grounds and other meteorological conditions are favourable, the locusts multiply very rapidly, giving rise to immense swarms which fly actively, leave the desert homes and invade

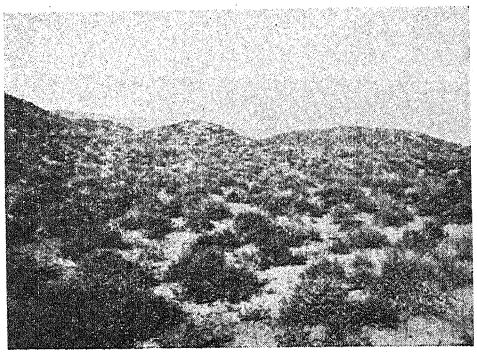

FIG. 3

Pasni Reks after rains (the scrub vegetation gives out lot of foliage)

the neighbouring parts of the country. This active phase of locusts in which they have the tendency to move in mass-flights is called the swarming or gregarious phase. The cycles of locust visitations referred to above are when the locust was in this phase.

General Biology of the Locust

The desert locust, like common grasshoppers, has three distinct stages in its life-history: (1) egg; (2) hopper, the name given to the young wingless individual, which moves about by hopping; and (3) adult or flier.

The freshly emerged fliers of swarming phase are pinkish in colour, but after a fortnight or so (during spring and summer) they become sexually mature, when they assume a distinct yellow colour. The adult locusts of the solitary phase are grey and are only slightly yellowish when mature.

The adult locusts although very active during the day usually do not fly during the night and on cloudy days. After sunset they generally settle down on crops and trees and feed on them. Most of the damage is thus done during 5 p.m. to 10 a.m.

The female lays eggs in moist soil, preferably soft, sandy or loose soil, after drilling a 3" to 6" deep hole with its abdomen. During her life-time a female has been observed to lay as many as eleven clusters containing 60 to 120 eggs each at an interval of about one week, so that the total number of eggs laid by a female may be over 800.

The eggs generally resemble rice grains. They hatch in about 2 weeks in summer and in 3 to 4 weeks in spring and autumn, depending on temperature and soil moisture.

Hoppers.—The hoppers of the solitary phase possess uniformly green colour throughout their life which harmonises with the colour of the food plants in which they conceal themselves. They do not form bands. The hoppers of the swarming phase are almost black during the first 2 to 3 stages but later develop yellow and greenish-yellow colour with black markings. They collect together to form bands and move in columns. The two phases mentioned above are interchangeable. If the swarming phase hoppers are thinned out by control operations or other adverse conditions and live an isolated life, they assume characters of solitary phase; on the other hand if solitary phase hoppers are massed together, they develop swarming phase characters.

The hopper or wingless stage lasts from 6 to 8 weeks in spring and 4 to 5 weeks during summer.

Nature and Extent of Damage

Immense destruction is caused by fliers but more so by hoppers. There are very few plants which are not eaten by locusts. They are capable of consuming the entire vegetation of a locality, devastating crops, completely defoliating and denuding fruit and shade trees. In the case of hoppers, the activities extend still further. They invade houses, enter kitchens, store rooms, etc., and make life miserable. Sometimes they fall into wells in millions and render the water unfit for drinking purposes. At times the hoppers block railway traffic for hours by making the line slippery on account of their crushed bodies. Since they remain restricted to particular places, the intensity of damage is more severe than in the case of adults which fly off from place to place.

Temperature affects considerably the activities of hoppers as of fliers. The hoppers are sluggish during cool hours of the day. At night they rest in bushes and in the morning when it becomes warm, they begin to march in large bands. They do not ordinarily change their direction of movement, but follow their path relentlessly.

Permanent Breeding Areas in India

There are two main permanent breeding areas in India:

(1) Desert area of Baluchistan—spring breeding area, which receives rainfall generally in winter.

(2) Desert areas of Sind-Rajputana—summer breeding area, which receives rainfall during summer.

The overwintering locusts start breeding in the desert areas of south Baluchistan

(Mekran) after winter rainfall, as soon as the weather conditions begin to warm up in February. The adults of first generation are produced by about middle of April. If the rainfall is also received in the interior of Baluchistan or the soil conditions are suitable otherwise for oviposition, as is sometimes the case in Kulanch, Kolwa and Kachhi areas, there may be another generation in May–June. Majority of these locusts then gradually migrate eastward, to Sind–Rajputana area, where they start breeding again on account of monsoon rainfall received during summer months. There may be two generations in the area if the conditions are favourable. Population of the locusts in this region rises during September–October, after which the adults migrate back to the winter-rainfall area, *i.e.*, Baluchistan, ready to breed during next spring.

It may be added that Arabia and Iran and other adjoining countries in the west resemble Baluchistan with regard to time of locust breeding and like the latter are sources of locusts received in Sind–Rajputana during summer.

The cycle of breeding and migration described above goes on year after year till suitable conditions, particularly rainfall, in either or both the breeding grounds help in mass multiplication and changing of the solitary into swarming phase. In the swarming phase, the distribution is unlimited and as already stated locusts reach distant provinces like Bengal and Madras.

Inauguration of Swarming Phase in 1940

After the last locust cycle ended in India in 1931–32, the locust was found for nine years in the desert tracts of Baluchistan, Sind and Rajputana in the solitary phase. In the summer of 1940, there was a change from solitary to the gregarious phase and the centre of development of this change was in Sind–Rajputana. A brief history of this change of phase is as follows:—

In the Persian Gulf coast of Mekran (Baluchistan), the highest population of overwintering locusts in the beginning of 1940 was about 240 per sq. mile, while very few specimens were traceable in the hinterlands. After the winter rainfall (about 2·25") received in the coastal areas and Kolwa valley in January and February, the locusts started ovipositing towards the end of February. Breeding was rather light and scattered. The hoppers emerged during the first week of March and completed their life-cycle by the middle of April. Scattered breeding was reported up to the middle of May. The population of adults of the spring generation was low. In Kachhi area (Kalat State), the population was 2,560 per sq. mile in June. The adults of the spring generation were all of the solitary phase.

From the foregoing, it is clear that the locust population in all the permanent breeding areas in Baluchistan in the spring and early summer of 1940 was not appreciably high, and nowhere was any incipient swarming observed.

In the desert tracts of Sind and Rajputana the locust population was lower than even in the previous year up to May 1940. Immigrants from the west began to appear in this area early in June as usual. The migrant forms were of grey colour and of solitary phase. Owing to the widespread precipitation received in May and June, the soil moisture conditions all over Sind–Rajputana became suitable for oviposition. In July hoppers of I–V stages in fair numbers were observed in Thar-Mallani parts of Sind, Jaisalmer, Jodhpur and Bikaner States. A further influx in locust population presumably as a result of some more migrants from west was recorded in July and the population density shot up to 8,000 per sq. mile in Thar–Mallani area and 2,080 in Bikaner State. A somewhat remarkable feature observed in this month was that a large proportion of the locusts from some localities showed intermediate and gregarious characters. Besides this, small loose swarms of sexually mature yellow locusts (of gregarious phase) appeared in Suratgarh and Lunkaransar tehsils of the Bikaner State in the second week of July and again early in August. Some of the yellow locusts were seen in north Jailsalmer also in the end of August and first week of September and later on spread to the south and south-west in this area. Concentrated oviposition, presumably took place over a wide area in Bikaner and Jaisalmer States and in Tharparkar district of Sind and the hoppers emerging in September bore gregarious characteristics and the adults which developed from them were pink in colour and formed swarms in the beginning of October.

It is rather difficult to accurately determine the origin of the yellow locusts of gregarious phase which appeared in Bikaner State in July. Judging from the poor breeding in the previous spring in Baluchistan it is clear that these swarms did not originate from

that area. On the other hand, the conditions being extremely favourable for crowded breeding in Sind–Rajputana in early summer on account of patchy vegetation after the prevalence of drought conditions for several years, it is possible that concentrated oviposition took place in some sparsely populated areas by grey migrants or indigenous adults in the end of May, leading to the development of gregarious individuals, which on obtaining sexual maturity became yellow. If this be so, it is evident that in case the conditions are favourable, the desert tracts of Sind–Rajputana can serve as an outbreak centre independent of Baluchistan.

The other source of origin of the gregarious individuals described above may be extra Indian. The history of immigrant swarms in Rajputana–Sind during 1941 shows that this source was really very important, but due to war conditions no information was or is available from foreign countries for the first half of 1940, except for a newspaper report in May that eastern Iraq was threatened with locust invasion.

The swarms, which originated in October–November 1940, from Bikaner and Jaisalmer States in Rajputana and Tharparkar district of Sind, flew towards the west and north-west and visited southern and western districts of the Punjab and N.W.F.P., North Sind and Baluchistan. Apparently some swarms went further west into Iran, Oman (Arabia), etc. Some flew towards the east visiting some southern and central states of Rajputana, south-eastern districts of the Punjab and some western districts of United Provinces. The swarms were most active in November and their activities continued up to January 1941.

In order to discover the overwintering areas of the swarms, the staff of the Locust Warning Organization, assisted by some other research staff of the Imperial Entomologist, carried out intensive and extensive surveys from December 1940–February 1941, of the areas visited by the swarms. In all these areas locusts were traceable, the maximum locust population on the Mekran coast was 26,000 per sq. mile, in Jhalawan 10,000 and in Kachhi 77,000. In Sind–Rajputana the highest population was 21,000 at Arjansar (Bikaner State). Spring breeding (1941) was particularly heavy in Jhalawan and Kachhi areas of Baluchistan, where soil remained suitable for oviposition up to the end of May owing to favourable rainfall and periodic flood waters received in that region. In Mekran the winter-spring precipitation was rather deficient, and therefore, there was only light breeding in most of the localities except in Dasht-Gwadar area, where owing to sufficient rainfall in February, hoppers in large numbers were observed in March and April 1941. Control operations were carried out mostly under the direction of the Locust Warning Organization in Mekran, Jhalawan and Kachhi (Kalat State) with the help of labour provided by the Baluchistan Administration. In Kachhi very heavy concentrations of overwintering locusts were traceable in the cultivated fields. Oviposition occurred in March and hoppers were observed about the middle of April. In some areas the hopper population was 78,00,000 per acre. About 50 per cent. of the IV–V stage hoppers were of gregarious phase. Several lakhs of adult locusts and millions of hoppers were destroyed by beating, baiting and burning and thereby the population was reduced considerably. In spite of the large breeding capacity of the locust, the maximum population in June 1941 was only 11,000 per sq. mile. Thus by continuous and systematic control work the population was reduced considerably and incipient swarming prevented. Therefore the chances of eastward migration of adult locusts to Rajputana were reduced to the minimum.

From the foregoing it is clear that there was no incipient swarming in Baluchistan during the last spring and early summer which is one of the important sources for the swarms for Rajputana and other parts of India. However, between the end of June and the first week of August two principal waves of immigrant swarms came from countries beyond the western borders of India. They flew over the whole of Rajputana and Western India States, touching Hissar in the east and some western districts of the Punjab in the north, but they laid eggs mostly in the Lasbela State (Baluchistan), Tharparkar district (Sind), Cutch and Tharad States (Western India), western parts of Jodhpur State and south-western parts of Jaisalmer State, etc., which received fair amount of rainfall in August–September. Active breeding was in progress in these areas during July, August and September. Oviposition took place on several occasions and by the end of August hoppers of all stages were met with. The hoppers started becoming adults from the

end of August onwards. The largest number of home-bred swarms originated from Tharparkar district of Sind, but Lasbela, Cutch, Jaisalmer and some areas in Rajputana have also contributed some swarms. The swarms, which have originated from Sind, Lasbela and Jaisalmer, have mostly flown in north and north-east direction and invaded the cultivated areas of North Sind, Khairpur and Bhawalpur States, south-eastern districts of Baluchistan and southern and south-western districts of the Punjab. The swarms originating from eastern Rajputana States also flew mostly from south-west to north-east and have visited Alwar, Hissar, Muttra and Aligarh districts in the east, and in the southern direction the swarms have flown over Bhopal and Indore in Central India and Hoshangabad, Nagpur and some other districts in the Central Provinces. So far detailed information has not been received about the areas of oviposition outside Rajputana by these home-bred swarms, but it appears that eggs have been laid in parts of Sind, Alwar State, Gwalior, Muttra and Aligarh districts of the United Provinces.

As the oviposition by the first batch of swarms took place in several series and breeding of second generation also started about the middle of September, it appears swarms will originate right up to the end of October, if not a few weeks later, unless the weather suddenly cools down. Last year the swarms continued to be active in north-west India right up to the end of December and restarted their activity in February.

Locust Control Organizations

The Government of India have a permanent Locust Warning Organization which is always engaged on the study of the rise and fall in the population of the locust, even when it is in the solitary phase, in different desert areas of North-West India. The staff of this organization carefully studies the conditions under which the locust lives and changes into the gregarious phase. As soon as the organization observed the locust in the incipient swarming phase last year, it warned all the Provinces and States likely to be invaded, of the possibility of the inauguration of a fresh locust cycle. Under the advice of the Central Locust Warning Organization, Governments of various Provinces and States established the locust control organizations, mostly consisting of Revenue Officers, the superior officers of which have been trained by the Central Locust Warning Organization in anti-locust work. These regional organizations have carried out extensive control work during this year. The Central Locust Warning Organization, apart from rendering help in the field in the choice of suitable control methods, has been keeping, from its headquarters at New Delhi, all the Provinces and States, informed of swarm movements and the intensity of breeding in various areas. In view of timely warnings, crops have been saved from considerable amount of damage and the saying 'forewarned is forearmed' has proved very true in the control of this pest.

INDUSTRIAL RESEARCH FUND

THE resolution recommending "that a fund, called the Industrial Research Fund, for the purpose of fostering industrial development in this country, be constituted and that provision be made in the budget for an annual grant of Rs. 10 lakhs to the Fund for a period of five years", moved by Sir A. Ramaswami Mudaliar, was accepted by the Central Assembly at its session, on the 14th November.

Sir A. Ramaswami Mudaliar explained in detail the valuable work carried out by the Board of Scientific and Industrial Research, since its inception 18 months ago, under the able guidance of Sir S. S. Bhatnagar. The Government considered that it was time that a separate fund be constituted for Scientific and Industrial Research, to place it on an independent and permanent footing. The Commerce Member payed a warm tribute to the work of Sir S. S. Bhatnagar and scientists all over the country, who have successfully investigated several problems of practical interest presented to them. The constitution of the Industrial Research Fund, which will be administered by a Board of Trustees consisting of some officials and prominent scientists and industrialists, will place the Board, more or less on a prominent footing and render possible the expansion of its activities.

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A NOTE ON THE SPECIFIC HEAT OF α QUARTZ

My attention has recently been drawn by a private communication from K. S. Pitzer, Department of Chemistry, University of California, to a paper by C. T. Anderson[1] on the heat capacities of quartz between 50° K. and 300° K. which I overlooked before. In my previous paper[2] on the subject the observed values of C_p between 23° K. and 273° K. were taken from Sosman's book (page 314) on Silica. These were obtained from an extrapolated curve between heat capacity and temperature drawn from the observations of several workers. Between 123° K. and 273° K. the course of the curve is not certain.

The figures given by Anderson are the heat capacities per gram formula weight of SiO_2, and are to be divided by 60 to get the value of C_p. The values for the following temperatures were obtained from a smooth curve between heat capacity and temperature drawn from his observations.

There is not a very marked difference between Sosman's values and those given by Anderson; however the latter show better agreement with the calculated values.

TABLE I

Temperature on the absolute scale	Andersons's value of heat capacity per gram formula weight	$C_p \times 10^3$	Sosman's value of $C_p \times 10^3$	Author's calculated value of $C_p \times 10^3$
50	1·390	23·2	23·5	25·9
73	2·500	41·7	41·0	44·9
92·6	3·445	57·4	56·9	59·6
123	4·810	80·2	77·4	81·2
173	6·895	114·9	111·4	113·8
223	8·620	143·5	141·2	141·2
273	10·030	167·2	166·4	166·0

BISHAMBHAR DAYAL SAKSENA.

D. A. V. College,
Cawnpore,
October 14, 1941.

[1] Anderson, *J. Amer. Chem. Soc.*, 1936, **58**, 568.
[2] Saksena, *Proc. Ind. Acad. Sci.*, 1940, **12 A**, 93.

A NON-FERMENTING TYPE OF THE TEA PLANT, *CAMELLIA THEA*, LINK.

RECENT experimental work with methods of tea selection has made much progress in most tea producing countries. The selection of the highest yielding bushes in different field groups has been the first approach followed by vegetative methods of propagation from selected plants. Selected high yielding tea plants however require weeding out on a quality basis, *i.e.*, on the quality characteristics of the tea made from each bush. The best quality bushes with the most desirable characters are not necessarily the highest yielders. The leaf yield at each harvesting from each single bush being so small in proportion to quantities of tea leaf manufactured commercially at each occasion, a special method of manufacture to deal with leaf from each bush, weighing up to 25 grams comprising about 40 individual shoots, has been devised. This method[1] for single bush manufacture was tested by carrying out a series of successive manufactures of flush from four pairs of different bushes. The method was found to be very satisfactory and even small quantities of withered leaf weighing 10 grams each were satisfactorily manufactured. The results obtained were highly consistent, the same differences of quality inherent in the different bushes being recognised by a tea taster in the samples from successive manufactures.

The bushes of each pair were adjacent to each other. Each of the four pairs tested were mature bushes, six years old, each pair originating from split seedlings and thus being identical. The leaf from each pair was gathered on the same day and manufactured separately. The flush from one pair after passing through the rolling process remained green and unfermented. The fired tea on infusion showed a very green infusion and the liquor was thin and green. The green character of the liquor was that of pungent, unfermented tea tannin. The other three pairs of bushes fermented normally. The fired teas on infusion exhibited normal characteristics of infusion and liquor. The leaf from both non-fermenting bushes was manufactured at varying degrees of wither with combinations of fermentation periods extending from six to twenty-four hours. The leaf remained in all cases green and unfermented.

The discovery of the non-fermenting character in each of the two bushes originating from the same split seedling reveals the existence of a genetical factor for fermentation which has not hitherto been taken into account. Further investigations have shown that there are many types of tea ranging from non-fermenting types through poor and medium types to types which ferment with extreme rapidity. That this factor is connected with the presence or absence of an oxidising enzyme system[2] has been recently demonstrated by the addition of oxidase preparation to non-fermenting leaf thus inducing normal fermentation.

P. R. PERERA.

Tea Research Institute of Ceylon,
St. Coombs, Talawakelle,
August 30, 1941.

[1] *The Tea Quarterly*, 1940, **13**, 43.
[2] *Biochemical Journal*, **34**, 1488.

PERMANENT LABELS FOR MICROSCOPE SLIDES

IN tropical countries paper labels on slides are liable to peel off owing to the humid air or to the large variations of temperature; most inks are liable to fade in strong light; fungi and insects, too, particularly the fish insect, attack the gum or the paper of the label; some insects scrape off the writing alone.

Dipping the paper label in some poisonous solution such as mercuric chloride protects it temporarily against fungi and insects but not against peeling off. For this last difficulty I have tried with success a thin paint of cellulose solution in amyl acetate applied with a brush in two or three coats. This preparation is commonly available in collapsible lead tubes under the trade name of "Duco cement". When applied thin it dries up almost immediately and forms a transparent and invisible

film extending beyond the edge of the label, which it thus further helps to fix to the slide.

For thin sections of fossil plants I have, however, found the following procedure excellent.

Grind with fine abrasive powder the part of the slide which you want to label, so as to remove the polish. On the ground surface you can write the label freely with a fine pointed lead pencil which should preferably be a hard one. Then place a drop of Canada Balsam on the writing and put on a coverslip. The Canada Balsam spreading under the coverslip at once makes the previously opaque ground surface transparent, leaving the pencil writing beautifully legible on a clear background. If the coverslip is surrounded by a border of the opaque ground surface the effect is elegant.

Obviously, this method has wider possibilities. For instance, it can be employed with advantage in labelling larger exhibits kept in glass show cases: the glass pane can be labelled on the inside, with the data written not on the pane (which would necessitate inverted writing) but on the coverglass itself. To make its surface receptive to the lead pencil the coverglass can be much more easily ground than the pane; for such purposes a thick coverglass, such as an ordinary microscope slide, can be used with advantage.

B. SAHNI.

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October 14, 1941.

AN INDIGENOUS MOUNTING MEDIUM FOR MICROSCOPIC WORK

BEFORE the war, a number of mounting media such as Canada balsam, 'Euparal', 'Diaphane' Glycerine Jelly, 'Karo', 'Clarite' (formerly known as Nevillite V), etc., have been in use in different scientific laboratories for microscopic work with animal or plant tissues. Almost all these are imported products and considerable difficulty has been experienced, of late, in securing adequate supplies of these mountants for class teaching and research work. This prompted an investigation into the properties of some indigenous resins with a view to using them as a substitute for Canada balsam, which is by far the most popular and universally employed microscopic mountant.

Attention was directed to 'Gurjan' balsam (from oil of *Dipterocarpus levis, D. alatus* and *D. turbinatus*), Dammar balsam (from species of *Shorea, Hopea* and *Balanocarpus*; Fam, Dipterocarpaceæ) and Rosin from Turpentine (*P. longifolia, P. excelsa* and other species growing in India). As solvent of the resins, turpentine, benzol and xylol were employed. Trichloroethylene was employed in some preliminary experiments but it has a tendency to make the solution too thin. Hence, its use was discontinued. Chemical analyses indicated that 'Gurjan' oil had a resin content of about 54% with an essential oil content varying from 20–82%, as compared to 66% of resin and 33% of volatile oil of Canada balsam (*Abies balsamea*). It was immediately evident that the high essential oil content in some brands of 'Gurjan' oil with their comparatively low resin content would militate against their use as substitutes for Canada balsam. If the high essential oil content of 'Gurjan' oil is brought down by distillation, the 'Gurjan' balsam may serve as a suitable substitute, but this would involve labour and expenditure not worth while undertaking as an economic proposition. Dammar* balsam (Gum Dummar, as it is sometimes called) and Rosin from turpentine were therefore chosen for more intensive study.

The experiments performed in this connection and the observations made are recorded in tabular form for convenience. In judging the suitability of any particular mounting medium, frequent comparisons were made with (1) standard mounting medium commonly used (*i.e.*, Neutral filtered Canada balsam in liquid form manufactured by Merck & Co.)

* Two varieties are stated to be common in India: (i) One variety indigenous to Bengal and (ii) One to the Malabar coast. It is available in the South Indian Market.

No. of Expt.	Mountant used with quantities	pH	Refractive Index	Solubility	Transparency	Drying power	Retention of stain in stained and mounted tissue specimens	Remarks
1	Rosin + Turpentine (5 gms.) (5cc.)	3·0 to 3·2	1·48	Not good. Better on heating in water bath	Fair	Fair, tendency to crystalize on long keeping and thus spoiling preparation	Tendency for hematoxyline stain to fade away being too acidic	Not suitable
2	Rosin + Turpentine (5 gms.) (5 cc.)	Highly acidic	..	Not good	Fair	..	Same as above	Too thin for a good mount
3	Rosin + Xylol (5 gms.) (5 cc)	Acidic	1·49	Fair	Fair	Not satisfactory	..	Not suitable
4	Dammar + Xylol (5 gms.) (7 cc.)	4·1	1·48	Fair	Fair	Not good	Fair upto 3 months	Cover slip does not stick in 4 days
5	Rosin + Dammar (2 gms.) (3 gms.) + Xylol (7 cc.)	4·2	1·48	Fair. Good on water bath	Good	Fair	Do	..
6	Rosin + Dammar (2 gms.) (3 gms.) + Turpentine (7 cc.)	3·7	1·49	Fair	Good	Comparatively poor	Do	Cover slip does not stick in 7 days
7	Rosin + Dammar (2 gms.) (3 gms.) + Benzol (7 cc.)	4·2	1·477	Fair. Good on water bath	Good	Good	Do	Cover slip sticks in about 4 days. Tendency to get cloudy before mounting
8	Canada Balsam (5 gms.) + Xylol (6 cc.)	Neutral	1·465	Good	Good	Good	Do	Do Disappears on warming slide.
9	'Euparal'	4·3	1·49 to 1·5	..	Good	Good	Intensifies hematoxyline stain	Tendency to cloudiness. Disappears on warming

and (2) 'Euparal' (a combination of Camsal, Sandarac, Eucalyptol and Paraldehyde), an imported ready-made mounting medium which is popular with many English technicians.

It will be seen from the table that a mixture of Rosin and Dammar resin in xylol or benzol (Nos. 5 and 7) appears to be a better substitute than either Dammar + Xylol or Rosin + Xylol. Benzol as a diluent is even better than xylol as it dries more quickly than xylol. There is often a cloudiness when the tissue is first mounted in this medium due to interlocking of air bubbles, but this is easily eliminated by warming the slide gently before adding the cover glass. Turpentine as a solvent for Dammar resin or Rosin has the disadvantage that quite often fractures or minute crystals appear under the cover glass blurring the vision and sometimes spoiling the preparation.

Mounts prepared with No. 7 or No. 5 medium have been found to retain transparency for more than 3 months, for which period observation has so far been recorded, and these do

not fade around the periphery or turn yellow on long keeping as frequently do those mounted in ordinary brands of Canada-balsam, which are often much more highly acidic than this medium. 'Euparal' tends to intensify hæmatoxylin stains but otherwise this medium appears to compare favourably with it in transparency and drying power. 'Euparal' has a higher index of refraction than Canada-balsam but this medium has practically the same refractive index as slide glass, which should be an advantage as far as transmission of light through the medium is concerned.

Microscopists who have not got a generous supply of Canada-balsam or 'Euparal' may give this mixed mounting medium a fair trial and suggest further improvements, if possible. Dammar resin and Rosin are easily available in the Indian market. Dammar is not often readily obtainable in a condition suitable for immediate use. If it is secured in the form of lumps of various sizes mixed with powdered material or debris, the lumps should be picked out, melted over a hot flame in a suitable container, and then the melted balsam poured into the desired solvent (Xylol or Benzol). This may preferably be filtered once or twice through a course filter-paper placed in a ridged funnel.

Our thanks are due to Prof. S. Ghosh, Professor of Chemistry, School of Tropical Medicine, under whose direction the analysis of 'Gurjan' balsam was carried out and to Prof. S. R. Bose, Professor of Botany, Carmichael Medical College, Calcutta, who confirmed the usefulness of this mounting medium in plant tissue preparations.

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ERGOT IN INDIA

THE only ergot hitherto reported in India is *Sphacelia sorghi* McRae, described by McRae[1] as the cause of a disease of jowar (*Sorghum vulgare* Pers.). It was suggested by Ajrekar[2] that this fungus is the imperfect stage of a species of *Claviceps*. In September and October 1941, the senior author found a severe attack of ergot on three different grasses in the neighbourhood of Simla at an altitude of 6,500 feet. The appearance of the ergots and conidial measurements on the several hosts were as follows:—

(1) *Brachypodium sylvaticum* Beauv.—Ergots slightly curved, up to 35 mm. long, 1·5–2 mm. diam., "dusky-brown" (Ridgway) in colour externally and "pale pinkish cinnamon" internally; conidia ovoid, $5{\cdot}5 \times 2{\cdot}9$ $(2{\cdot}1–7{\cdot}8 \times 1{\cdot}8–3{\cdot}9)\mu$. Collected October 11th, 1941.

(2) *Oplismenus compositus* Beauv.—Distinctly curved, up to 9 mm. long, 1–1·5 mm. diam., "chaetura black" externally, white internally; conidia ovoid to cylindrical, $5{\cdot}2 \times 2{\cdot}0$ $(3{\cdot}9–6{\cdot}1 \times 1{\cdot}8–2{\cdot}8)\mu$. Collected October 11th, 1941.

(3) *Andropogon* (? *Gryllus* L.).—Very slightly curved, up to 14 mm. long, 1–1·5 mm. diam., "sooty-black" externally and white internally; conidia spherical to ovoid, $5{\cdot}6 \times 3{\cdot}0$ $(3{\cdot}6–11{\cdot}0 \times 1{\cdot}8–4{\cdot}6)\mu$. Collected October 10th, 1941.

In all cases the sclerotia are typical of those of *Claviceps*, and they undoubtedly belong to a representative of this genus.

The species of *Claviceps* cannot be determined for certainty in the absence of the perfect stage of the fungus. *Claviceps purpurea* (Fr.) Tul. is known to occur on *Brachypodium sylvaticum; C. pusilla* Ces. is known on *Andropogon ischæmon* L. The difference between these two species of *Claviceps* is chiefly in the colour of the stipe and head; the sclerotia of the Simla collections fit well the description of either of these fungi. The collections on the above grasses were made in one vicinity, and all three

may be *C. purpurea* or *C. pusilla*. The conidia are rather large for the former.

Ergots of several species of *Claviceps* are of the greatest economic importance. In the first place they are poisonous to humans and animals if consumed in large quantities. Secondly, from ergot is derived ergotoxine, a most important medical drug, of which at the present moment there is a shortage. The ergotoxine content and the possibility of exploiting the Indian fungus have to be investigated.

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G. WATTS PADWICK.

Imp. Agric. Res. Institute,
New Delhi,
November 4, 1941.

[1] McRae, W., *Madras Agric. Yearb.*, 1917, 109.
[2] Ajrekar, S. L., *J. Ind. Bot. Soc.*, 1926, **5**, 55.

TEMPERATURE VARIATION OF SOUND VELOCITY IN LIQUIDS

IN a paper on the viscosity of liquids Andrade[1] has shown that

$$\eta \propto \frac{\nu}{\sigma} \qquad (1)$$

where η is viscosity, ν the frequency of vibration of a molecule of the liquid and σ the intermolecular distance. Wheeler[2] also has given the same type of equation.

According to Rama Rao[3]

$$v \propto \frac{1}{\sigma^9} \qquad (2)$$

where v is the velocity of sound in the liquid. Assuming that

$$\nu \propto \frac{1}{\sigma^n} \qquad (3)$$

where n is an integer, we get by combining (1), (2) and (3) that

$$\eta \propto v^{\frac{n+1}{9}}. \qquad (4)$$

Now, Andrade[1] and others[4] have developed the equation

$$\eta = Ae^{\frac{B}{T}} \qquad (5)$$

where A and B are constants of the liquid and T the absolute temperature. This equation gives the temperature variation of viscosity and this is true for many liquids. Combining (5) with (4) we get

$$v = L^{e^{\frac{S}{T}}} \qquad (6)$$

where L and S are constants dependent on the liquid.

The relation (6) holds good very well in many liquids. When log v is plotted against $\frac{1}{T}$ for different liquids, straight lines are obtained (Fig. 1) as is to be expected from the relation

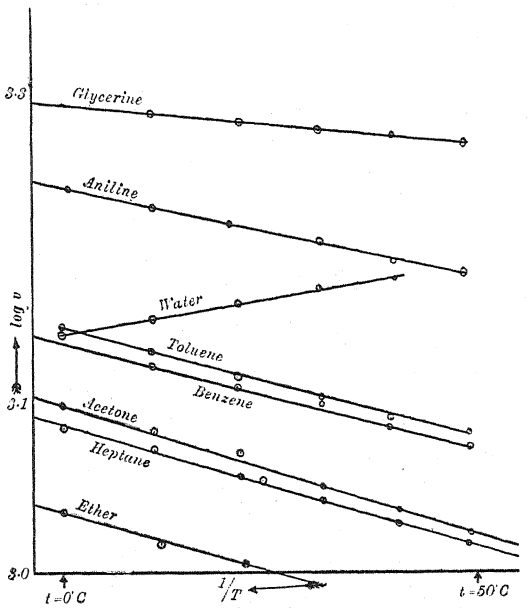

FIG. 1

(6). The constants L and S are not merely arbitrary in character but have some special significance. This is shown by the fact that changes in molecular weight and structure are accompanied by a change in the position and slope of the lines (Fig. 1).

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129, Uriopet,
Bangalore City,
June 12, 1941.

[1] Andrade, *Phil. Mag.*, 1934.
[2] T. S. Wheeler, *Trans. Nat. Inst. Sci. of India*, 1938, **1**, 333.
[3] Rama Rao, M., *Ind. Jour. of Phy.*, 1940, **14**, 109.
[4] Venkatarama Iyer, M. P., *Ibid.*, 1930, **5**, 371.

NOTE ON A NEW GENE AFFECTING LEAF SHAPE IN ASIATIC COTTONS*

HUTCHINSON[1] AND SILOW[2] have described in detail the inheritance of leaf shape in Asiatic cottons. In addition to the series of multiple alleles L^L, L^N, L^A L and *l* giving a range of types from laciniated to broad, there exist two broad leaved allelic members of the same series, L^B and L^J, which arose by mutation in an L^L plant. Their studies have contributed to a valuable discussion of the organisation of a gene locus, and therefore, the new form of leaf shape reported in the present note should prove of more than common interest.

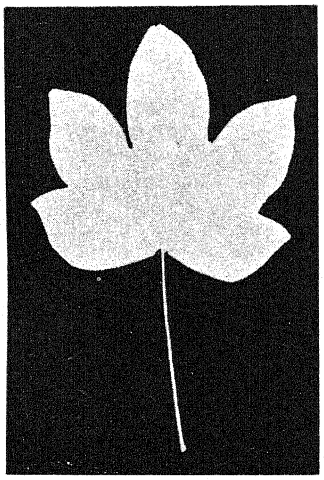

FIG. 1

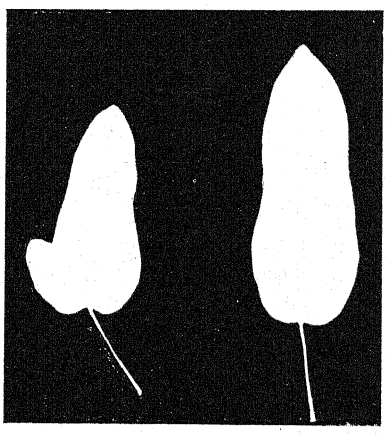

FIG. 2

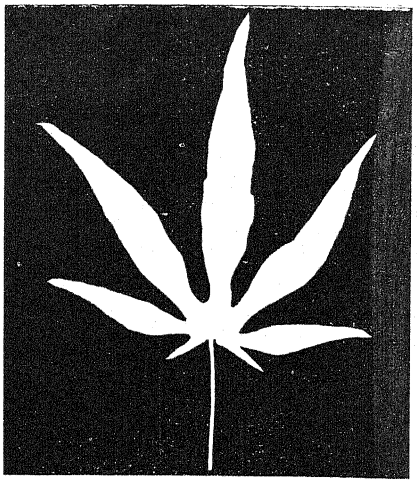

FIG. 3

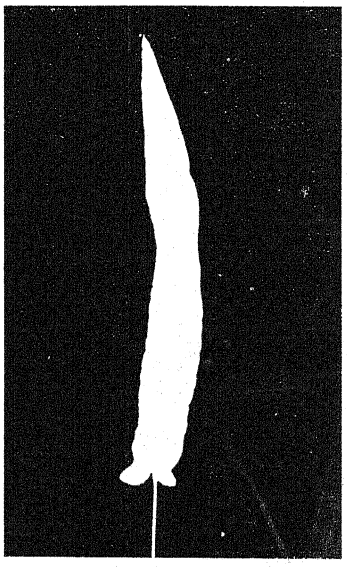

FIG. 4

In all members of the *L* series of alleles, the leaf is characterised by 3–7 lobes (Figs. 1 and 3), the middle lobe being the longest. A type of leaf shape illustrated in the photograph (Fig. 2) arose as a mutant (isolated by Rao Bahadur V. Ramanathan at Coimbatore) in the South Indian variety known as C_7, a form of *G. arboreum* var. *neglectum* f. *indica*. C_7 has a 3-lobed broad leaf (Fig. 1). In the mutant plant, the first one or two leaves are

* The work described in this note is being conducted under the Cotton Genetics Research Scheme, Indore, financed by the Indian Central Cotton Committee.

nearly normal, but later leaves show a progressive reduction of the two lateral lobes resulting in tadpole-shaped leaves and ultimately the leaves consist of only the single middle lobe. In a normal broad leaf, the ratio of length of middle lobe to the length of the lateral lobe ranges from 1·1 to 1·3 and in the mutant measured in the earlier leaves the range is from 1·6 to 2·0. Evidence is presented below to show that the leaf shape gene carried by the C_7 mutant is not a member of the L series of alleles and that normally there is a single factor difference between the single mutant and normal broad. The symbol S — s may be given to the lobed-single pair of alleles.

The mutant, *ll ss*, was crossed to Malvi, *ll SS*, A_1 and Kokati narrow, *LL SS*, A_8, L^LL^L SS and A_9, L^BL^B SS. All F_1s had normal 3–7 lobed leaves showing complete dominance of the lobed leaf over the mutant type of leaf.

An F_2 family of Malvi × Mutant single gave 40 normal: 13 single, almost exactly 3 : 1. There is therefore in this cross a single factor difference between normal and mutant.

Four F_2 families of the cross A_8 × Mutant gave a four-class segregation: laciniated-lobed, laciniated-single, broad-lobed and broad-single. Similarly, in the six F_2 families of the cross A_1 × Mutant, four phenotypes could be made out: narrow-lobed, narrow-single, broad-lobed and broad-single. The occurrence in these crosses of the four phenotypes involving recombination between L and S loci shows that the S-s gene locus is not a member of the L series of allelomorphs. These phenotypes are illustrated in the accompanying photograph.

The proportions of the four phenotyes in the F_2 families of A_8 × Mutant and A_1 × Mutant deviate considerably from 9 : 3 : 3 : 1 expectation. Again, many of the F_3 families of the cross Malvi × Mutant give a significant departure from 3 : 1 expectation, while a few families give a good fit to the expected 3 : 1 ratio. Further work to elucidate the genetics of the single mutant is in progress.

We are indebted to Rao Bahadur V. Ramanathan, Cotton Specialist, Madras, for kindly supplying seeds of the mutant.

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Indore,
November 7, 1941.

[1] Hutchinson, J. B., *J. Genet.*, 1934, **28**, 437.
[2] Silow, R. A., *Ibid.*, 1939, **38**, 229.

THE INHERITANCE OF PURPLE PIGMENT AT THE BASE OF ANTHERS IN SORGHUM

In almost all cultivated sorghums the fresh anthers are yellow in colour. The inheritance of purple pigment occurring in the anthers of a few African varieties of sorghum has been recorded.[1] They have been noted to have their grain either brown or have the factor for brown as evidenced by the colour of the dry anther.

Most of the Asiatic sorghums have yellow or light yellow anthers with no purple on them. In a South Indian variety of *Sorghum dochna* with its anthers light yellow and grain white, there occurred in 1925 a heterozygous mutant with brown grains and the base of the anthers coloured purple. There was no other type with purple-based anthers in the whole of the Coimbatore collection. This mutant was sown and segregated giving 129 plants like the mutant and 37 like the mother type. In subsequent generations there was the usual repetition of monohybrid segregation, the total of 8 families being 973 plants with brown grain and purple at the base of the anthers, and 320 plants with white grain and mere light yellow anthers. A type pure for purple at the base of the anthers and brown grain has been fixed, and is constant for this character. The hybrid of the cross between this new type and the mother type segregated into brown grain with purple-based anthers and white grain with no purple in the anthers in the proportion of 3 : 1, the other characters remaining pure. It is remarkable that every plant with the base of the

anther purple had its grain brown. No white grain occurred in plants with purple-based anthers.

A gene designated A_b is responsible for the manifestation of purple colour at the base of the anther. The ordinary non-purple pigmented yellow anther has the gene a_b There is a very close association between A_b and one of the two B factors[2] responsible for the production of brown colour in the pericarp of the sorghum grain.

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November 6, 1941.

[1] *Proc. Ind. Acad. Sci.*, 1938, **8**, 317.
[2] *Ind. Jour. Agri. Sci.*, 1934, **4**, 81.

THE INHERITANCE OF DEPTH OF GREEN COLOUR IN THE LEAVES OF SORGHUM

IN the world collection of sorghum varieties grown and studied at the Millets Breeding Station, Coimbatore, it was noticed that the varietal blocks varied in the depth of green colour in mass effect. Three distinct groups could be made out. The commonest was the Green. The other smaller groups were Dark Green and Light Green. The three tints of green have proved to be varietal characteristics and remain constant through years. Being a mass-effect character, its pursuit in inheritance through individuals is beset with difficulties. From experience it has been found that the best time to read the character is when the plants are 5 to 6 weeks old. Before and after that period the differences tend to blend, and make classification dubious. When grown in mass, differences could always be made till the leaves begin to desiccate with age. An estimation of chlorophyll content showed that the green and dark green contained 17 and 22 per cent. more chlorophyll than the light green. There was more of chlorophyll *a* in light green and more of chlorophyll *b* in the other two groups.

The broad distribution of the three types among the groups of sorghums, both wild and cultivated, is as follows: Dark green—All wild sorghums except the Para sorghums, and most of the African varieties. Green—The Para sorghums and the Indian varieties. Light green —Chinese varieties. Typical of the three grades are the African Caffra sub-series for dark green, the Indian Durra sub-series for green, and the Chinese *Sorghum nervosum* for light green. Sorghums intercross freely and there have been varietal migrations with the result that stray combinations of other characters with the three leaf tints, are naturally met with.

To determine the inheritance of this character, crosses among the three types were made and the results are given below. The first cross was between A.S. 3464 (dark green) and A.S. 367 (green). The F_1 was dark green. The segregation in the F_2 (total of 6 families) gave 749 dark green and 244 green plants. In the F_3, out of 23 selections of dark green sown, 7 bred pure and 16 segregated again giving a total of 1,003 dark green and 334 green plants. All the 6 green selections bred pure. The second cross was between A.S. 367 (green) and A.S. 1741 (light green). The F_1 was green. The F_2 (family A.S. 6731) segregated and gave 138 green and 46 light green plants. In the F_3 generation, of the 3 selections of green, one bred pure, and the other 2 segregated giving between them 232 green and 66 light green plants. The third cross was between A.S. 3872 (dark green) and A.S. 1741 (light green). The F_1 was dark green. The F_2 (family A.S. 6730) segregated for all the three types giving 150 dark green, 84 green and 13 light green plants, a 9 : 6 : 1 ratio. In the F_3 generation, of the 6 selections of dark green sown, one bred pure, 3 gave a total of 263 dark green, 172 green and 25 light green plants, and 2 gave 181 dark green and 63 green plants. Of the 4 selections of green, 2 bred pure and 2 gave 108 green and 34 light green plants. The only selection of light green sown bred pure as expected.

From the above data it will be noticed that in the leaf colour of sorghum, Dark Green is a monogenic dominant to Green, and Green a monogenic dominant to Light Green, and that when there is segregation for all three characters, the ratio is 9 : 6 : 1 of Dark Green, Green and Light Green. Two supplementary factors for chlorophyll colour—C_1 and C_2—operate. Either of them can deepen Light Green into Green. Both of them have to be present to produce a Dark Green type.

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November 6, 1941.

PITYROGRAMMA CALOMELANOS, LINK., IN BENGAL

Pityrogramma calomelanos, Link. (Syn. *Gymnogramme calomelanos*, Kaulf.; *Ceropteris calomelanos* Und.) is a popular greenhouse fern introduced into cultivation from the West Indies about 150 years ago; but there is no mention of it in the older works and papers on Indian ferns.

Writing in 1922, Blatter and d'Almeida[1] stated that it had run wild in and about Bombay and was becoming naturalized in the Nilgiris. Its occurrence in the district of Purnea (Bihar) was recorded by Haines[2] in 1924. In 1930 Mehra[3] found it growing abundantly in a state of nature in certain parts of Sikkim. In a letter to Dr. P. Maheshwari (2–7–41), Dr. S. K. Mukerjee, Curator of the Herbarium, Royal Botanic Garden, Sibpur, states that from a sheet preserved there, it appears that the plant was collected in a wild state from Kurseong as early as 1921, that Dr. K. Biswas recently collected it from the roadside at Rorathang in the Darjeeling district, and that it has also been recorded from Mercara, Coorg.

No record thus exists of the plant having hitherto been collected anywhere in the plain districts of Bengal. It will therefore be of interest to note that in the course of a collecting tour in the district of Chittagong in September and October, 1940, the writer discovered the plant growing wild in the town of Chittagong and that it has also been found growing unrecognised on the walls of two fernhouses at the Government Nursery, Dacca.

Although of American origin, this fern has, according to Holttum,[4] become well established in Asia, the wind having apparently played a considerable part in the dispersal of spores as strikingly demonstrated in the case of the reappearance of vegetable life on the volcanic island of Krakatoa (Krakatau) in the Dutch East Indies after the great and destructive eruption of 1883. At Chittagong the plant was found to occur rather sparingly on the sides of certain ravines and cuttings, mixed with other vegetation, the spores having in all probability been derived at some time or other from cultivated plants in the bungalows on the tops of the neighbouring hillocks. At Dacca the spores or prothalli must have originally come with pots of other pteridophytes obtained for the Nursery. Only a couple of plants were noticed here during the rains of 1940, but they have since been gradually spreading in the neighbourhood.

It may be incidentally mentioned here that Underwood was the author of the combination "*Ceropteris calomelanos*" and not Linnaeus as stated by Mehra in his paper and the correct citation should have been "*Ceropteris calomelanos* (L.) Und."; the name now accepted is that given at the head of this article.

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Dacca University,
September 30, 1941.

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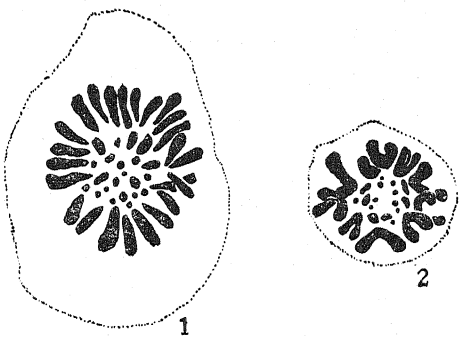
SPERMATOGONIAL CHROMOSOMES OF TWO INDIAN LIZARDS, *HEMIDACTYLUS FLAVIVIRIDIS* RÜPPELL AND *MABUYA MACULARIA* BLYTH

In a previous note to this *Journal*[1] we have given an account of the chromosomes of an Agamid lizard, *Calotes versicolor* Boulen., the common blood-sucker. In the present note we propose to give an account of the spermatogonial chromosomes of two more Indian lizards, *Hemidactylus flaviviridis* Rüppell (Family Gekkonidæ) and *Mabuya macularia* Blyth (Family Scincidæ). The first mentioned species is more commonly found inside human dwellings than outside all over Northern Gujarat and is one of the 17 species of that genus described by Smith.[2] The other lizard also is common in this region. It usually hides itself below stones or takes cover under grass and rotten foliage of trees like *Salvadora persica*. It frequently takes shelter in the shady parts of the hedges formed by *Euphorbia neriifolia* and *Capparis sepiaria* on the sandy tracts of Northern Gujarat. According to the observations made by one[3] of us the breeding season of *Mabuya macularia* Blyth extends from about the middle of July to mid-September. The colouration of the species, particularly of the male, undergoes a marked change in this season. The underside of the throat and most of the anterior half of the body is transformed into brick red from pinkish white.

The periodicity in the male gonads of these two lizards has been studied and the histological changes in them have been followed. The object of the present note, however, is to give a brief account of the chromosomes in the primary spermatogonia of these two lizards.

The male gonads were fixed all the year round at night between 11 p.m. and 5 a.m., as in the case of *Calotes*, in Oguma's fixative, Flemming with acetic acid, Bouin, Allen and Bouin and dehydrated by the usual methods. It was cut into sections 10–12 micra thick and stained with Heidenhain's iron-hæmatoxylin. The sections were differentiated with a saturated solution of picric acid. The first one of these fixatives proved to be very helpful in the case of *Hemidactylus*. Figs. 1 and 2 show the polar view of the spindle in the primary spermatogonia of *Hemidactylus flaviviridis* and *Mabuya macularia* respectively.



Hemidactylus flaviviridis Rüppell.—Polar view of spermatogonial metaphase plate. × 2,000 approx.

Mabuya macularia Blyth.—Polar view of spermatogonial metaphase plate. × 2,000 approx.

It will be seen from Fig. 1 that there are 46 chromosomes in the chromosomal complex of *Hemidacatylus flaviviridis* and that this garniture is made up of two classes of chromosomes, rod-shaped macrosomes and small dot-like microsomes. There are no V- or J-shaped chromosomes in the complex of this lizard and this is in conformity with the observations of Nakamura[4] (1931) on some other forms belonging to this family. The macrosomes are usually 24, but sometimes 23, and lie at the periphery of the spindle. Inside these there are small rods which show gradual diminution in size and pass through imperceptible gradation into microsomes. The number of dot-like microsomes is 12 (13 in the case of those plates where there are 23 rods at the periphery) and these lie in the central part of the plate. All the chromosomes are attached terminally.

In a primary spermatogonium of *Mabuya macularia* there are 26 chromosomes made up of three classes of elements as follows (Fig. 2):—

(1) 10 V-shaped chromosomes distributed at the periphery of the spindle and attached atelomitically;

(2) 6 batonnets attached terminally but lying inside the ring formed by 10 V-shaped macrosomes;

(3) 10 small dot-like microsomes occupying the central part of the metaphase plate.

The batonnets as well as dot-like microsomes are attached terminally to the spindle fibres. The chromosomal complex of this skink conforms to *"le complexe scinco-lacertoide"* of Matthey[5] (1931).

A careful analysis of the chromosomal complexes of these two lizards has revealed some noteworthy features in which these complexes resemble those of other lizards we have studied which we hope to discuss elsewhere.

J. J. ASANA.
T. S. MAHABALE.

Gujarat College,
Ahmedabad,
October 20, 1941.

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[3] Asana, J. J., *Proc. Ind. Sci. Cong.*, 1932, **19**, 266.
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DISCOVERY OF CELESTITE IN THE TRICHINOPOLY DISTRICT

IN connection with the note published in *Current Science* of June 1941 (p. 299) above the signature of Dr. N. Jayaraman, I may be permitted to make the following observations.

I now learn that the lump of celestite referred to was entirely different from the one given by the *Trichinopoly Mining Works, Ltd.*, to a member of the staff of the Indian Institute of Science, and the firm's belief in the identity of the two was mistaken. Dr. Jayaraman may therefore be credited with the rediscovery of the mineral by himself. The firm does, however, claim that its agents found the heavy mineral (known to them later as celestite) in their gypsum area around Karai in or before January 1939.

Regarding the area to which Dr. Jayaraman's estimates refer, I quote here the relevant paragraph from his announcement in the *Hindu* of 4th January 1940.

> "Mr. Jayaraman, who has just returned from a survey of the newly found deposits, states that the minerals (*i.e.*, celestite and strontianite) occur in a free state in considerable quantities over a large region and particularly rich *in an area of* 1,500 *acres in Karai village* near Utatur. On a rough preliminary survey it is estimated that *this* area contains about a million tons of celestite and strontianite (Italics and parentheses mine).

Reading the above, I was naturally led to the conclusion that the area in question was the 1,500 acres around Karai, and not the larger region. However, Dr. Jayaraman has since explained that he meant the larger region.

I freely admit that I was inaccurate in stating (in my report published by the Madras Government as Development Department G.O. 735 dated the 10th April 1941) that Drs. Krishnaswami and Jayaraman reported the presence of celestite *and strontianite* in the cracks of phosphatic nodules. That the error was inadvertent will be shown by the fact that I have reported these authors correctly in the Geological Survey Bulletin No. 2 on Strontium.

Ignoring Dr. Jayaraman's sarcasm about 'rough hammer tests' which unfortunately no field geologist can dispense with, I may say that Dr. Jayaraman is not justified in making a generalisation about a large area from the examination of the nodules from a limited area, since my field work extending over two months in that region led me to different conclusions. Dr. Jayaraman's last sentence regarding the sparseness of distribution of strontium carbonate is now a welcome correction.

M. S. KRISHNAN.

Geological Survey of India,
Calcutta,
September 9, 1941.

REVIEWS

Mercerising. By J. T. Marsh. (Chapman & Hall, Ltd., London), 1941. Pp. xv + 458. Price 32*sh.*

Mr. Marsh has made a very valuable contribution to the literature of textile chemistry. As stated in the cover page with justification, no book has appeared on the subject for thirty years, although mercerisation has continued to be the most important process by which such qualities of cotton yarn and fabric as lustre and dyestuff absorption, can be improved. The action of caustic soda, and of other reagents capable of producing like effects by their swelling power, on cotton has, however, been studied and reported on in numerous publications in journals. Mr. Marsh's book is a comprehensive survey in which the latest advances have been noted and every aspect of the subject has received adequate treatment. The history of the various discoveries concerning mercerisation, the technology of the process, the methods of examination of mercerised materials, and the theoretical basis, physical and chemical, of the action have all been described with a wealth of detail that makes the book of equal value to the textile chemist in the laboratory and to the practical processer. The latter will find the account of the machinery for yarn and cloth, the discussion of the factors to be controlled during the large-scale operation, the examination of the relative merits of carrying out the mercerising process after various stages of pretreatment, and the quantitative evaluation of the effect obtained, to be of the utmost help in his day to day handling of plant and processes.

A somewhat different arrangement of the chapters and reduction in the length of the book with advantage to clarity could have been suggested. The chemistry of cellulose and its modification or degradation productions has been so fully treated in Doree's "Methods of Cellulose Chemistry" and the author's own recent treatise (jointly with Wood) on the "Chemistry of Cellulose" that it might have been largely omitted from the present volume except in so far as it related to the mercerising process. The statement regarding the reactivity ratio being the only absolute method, or in fact in any sense at all an "absolute" method, is questionable. One aspect of mercerisation which deserves more extensive treatment than the author has been able to give, is the use of wetting or penetrating agents and their relation, with regard to chemical constitution and specific properties, to the wetting agents used in other wet processes for textiles. References to the work of Mark and Meyer and other continental investigators are brief and casual, while there is a tendency to regard the publications of the Shirley Institute (The British Cotton Industry Research Association), extremely valuable and important as they are, as constituting more or less the entire literature of textile research.

The book should find a place in the library of every cotton mill in the country. There is perhaps no process in the conversion of grey cotton to finished fabric which is so badly neglected in our mills as mercerisation, and a perusal of "Mercerising" will be a salutary reminder of the careful study and control of many factors that are necessary if the highest efficiency is desired.

K. VENKATARAMAN.

Canning Practice and Control. By Osman Jones and T. W. Jones. (Chapman & Hall, Ltd.), 1941. Second edition. Pp. 311. 32*sh.*

The appearance of an enlarged edition of this book of recognised practical value is opportune in that it coincides with a close of a decade that has witnessed a phenomenal development in our knowledge of the scientific principles of canning. So rapid has been the progress in scientific canning and the adoption of its recent discoveries to commercial practice that, after only three years of its first publication, a revision of this very useful book became essential. The authors are naturally gratified by the reception accorded to the first edition by canners all over the world. Their experience both in the laboratory and in the factory has, indeed, afforded them an unrivalled opportunity to deal with the subject in all its aspects authoritatively. The enlarged edition contains an up-to-date and exhaustive collection of experimental results so far

obtained on the subject and it will undoubtedly be of lasting value as a reference volume to canners and research workers in this field.

Very little of the first edition has been modified, but considerable additions have been made particularly to chapters VI, VII, IX, XIII and XIV; chapter III has also been greatly enlarged to include developments in practically all branches of the subject and is considered to be one of the most important in the book. A new feature of the revised edition is the inclusion of chapter IV on the packing of foods in glass containers as this practice is in vogue in many canneries.

Considering the immense diversity, both in substance and kind, of the foods packed and the fact that the industry of canning is transgressing the rule-of-thumb stage, it is indeed a laudable attempt on the part of the authors to have very ably incorporated in the book pertinent material relating to the more recent factory practices and chemical and biological methods which ultimately aid in controlling the quality of canned foods.

The subject-matter of the second edition is divided into sixteen chapters. The first chapter deals with the statistics relating to production, consumption and import of canned foods as well as the growth of canning industry in the United Kingdom. Essential features of factory location, erection and equipment are then considered in detail with special reference to the canning of peas. That the American practices form the foundation upon which the United Kingdom has based its factory operations is obvious. The chapter on canning is exceptionally useful and deserves special mention. This chapter includes an exhaustive discussion on various essential operations involved in the canning of foods and problems connected therewith, and also information on tin plate manufacture and the industrial process of lacquering. Under the discussion on the packing of foods in glass containers it is interesting to read on p. 86 that serious losses during canning can be avoided by testing the quality of glass containers by means of a mechanical device called "Strain-Viewer". Since all branches of food production are becoming highly specialised industries needing scientific control, hints on the canning laboratory and its work will provide useful guidance to those concerned with the establishment of a reasonably well-equipped canning laboratory. Chemical determinations of definite constituents and impurities in raw foodstuffs, chemical tests to determine the quality of can or glass containers and external and internal examination of canned foods by the application of new analytical methods have been carefully explained. Quality of water for the canned food factory had not, hitherto, received much attention and therefore, a good deal of emphasis has been laid upon the necessity for a chemical and bacteriological examination of water. The inclusion of recent work on microbiology with special reference to thermophilic organisms has rendered the subject-matter thoroughly informatory. The chapter on the effect of canning upon nutritive value is brought up-to-date by the inclusion of recent work on the vitamin value of canned foods. Valuable information has been furnished on the possibilities of converting cannery waste, consisting of fluid effluent, solid refuse and vegetable, meat and fish waste into saleable by-products of medicinal value. The concluding chapter deals with cannery hygiene which is a pre-requisite for controlling the quality of canned foodstuffs.

No serious errors are noticeable in the book but a few minor ones have unfortunately escaped the attention of the editors which, however, do not affect the sound structure of the book. Citation to reference 8 on page 37 is not correct. References 7, 24 and 31; 2; 2, 4, 9 and 44; and 5 and 9 listed in the bibliography on pages 83, 234, 269 and 293 respectively are not indicated in the text. Authors McCartney on page 229 and MacHenry on page 273 are misprinted in the bibliography as McCaitney and McHenry respectively. Serial number 28 of the bibliography on page 83 is repeated. The first one should read 27. Reference to Savage on page 204 should read 2 instead of 1. Reference numbers to Weigert and Stitt on pages 227 and 231 respectively are not correctly indicated in the text and the bibliography. References to Cameron and Yesaie and Clark and Tanner on page 270 should be listed in the bibliography as serial numbers 39 and 40 instead of 40 and 39 respectively. Tables on pages 158–160 and 170–171 are not serially numbered.

A conspicuous omission in the text is the discussion on discolouration in preserved products; the subject of spoilage of canned

foods is not dealt with in sufficient detail. We trust that these subjects will receive adequate treatment in the next edition.

I. A. SAYED.

The Common Commercial Timbers of India and Their Uses. By H. Trotter, I.F.S. (Manager of Publications, Delhi), 1941. Pp. 234. Price Rs. 2 or 3*sh.*

This publication is the second and revised edition of the original book which first appeared some ten years ago. During this interval a considerable amount of research work has been done on Indian timbers and their utilization. Also, a wider section of the public now appreciate that all timbers cannot be equally good for all jobs and that there is such a thing as using the right timber in the right way for any given purpose. The first edition had thus outlived its usefulness. It is the object of this, the second edition, to help the user to make the most of Indian timbers in the light of the latest available technical data. And Mr. Trotter, ably assisted by the experts in charge of the various sections of Utilisation at the Forest Research Institute, Dehra Dun, has produced a book which being concise, technically authoritative but not abstruse, neatly meets the requirements of the lay user of timber who needs *practical* assistance in his daily job.

It is the chief merit of "The Commercial Timbers of India" that it is intensely practical and the author has severely eschewed those aspects of his theme which, however interesting scientifically, controversial or even important, have no practical value in their utilisation. The first four chapters deal with the storage, seasoning, kiln drying and preservation of wood. Chapter V contains a description of common Indian woods. The sixth and the concluding chapter is the prescriptive part of the book and lists "woods recommended for various uses" ranging from aeroplanes to walking sticks—a remarkable list which is at once a tribute to the versatility of wood and to the obvious care and thoroughness with which the book has been written. Two appendices, the first dealing with the comparative strengths of Indian timbers in terms of the values for teak and the second—a very necessary Index of scientific and vernacular names—add to the value of the publication.

While the photographs are not bad, the few diagrams illustrating the text cannot be said to be very clear. Plate II faces the page the wrong way. Mr. Trotter in the preface says that "*Some* Burma species .... have .... been omitted, since Burma is now separated from India". This may be logical but, Burma still continues to supply Indian markets and one cannot help wishing that the author had not made this deletion. The "Trade names" and the "Vernacular names" will not, perhaps commend to universal acceptance because even trade names vary regionally in India; as for vernacular names the actual language in which the name is current is not always indicated (for example on p. 133 for *Michelia champaka*). It is also not very clear on what basis the vernaculars themselves have been chosen for, one occasionally finds the Coorg equivalent of a timber name but not the Mysore or Tamil equivalents. It would be preferable to consistently use (as has not been done on p. 27) italics to denote proprietary brands of preservatives and chemicals for sap stain control. And in Chapter VI on "woods recommended for various uses", one misses the important modern uses of wood—wood flour in the plastics industry, as also the use of wood for bearings. This is presumably due to lack of adequate data which alone would warrant their incorporation in a book primarily meant for the layman.

All these are minor details which do not materially affect the admirable general plan of the book. Here is a volume which is very good investment for a modest Rs. 2 to the timber merchant and the timber user and which should go a very long way in dispelling the not yet extinct fallacy that timber research is the abstruse pastime of well meaning but slightly distorted minds who have no notion of what "the man in the trade" wants.

Radio Frequency Measurements by Bridge and Resonance Methods. By L. Hartshorn. (Chapman & Hall, Ltd., London.) Pp. 282, 99 figures. Price 21*sh.*

This book is the tenth in the series of monographs on electrical engineering published under the editorship of H. P. Young. It is a comprehensive volume dealing with the principles underlying radio-frequency measurements.

The auhor states in the Preface that his aim has been to present, not an encyclopædic account of everything that has been written on the subject, but a systematic

account of the basic principles involved in radio-frequency technique. This aim has been admirably maintained. The book is in three parts. The first part is devoted to a clear exposition of the general principles underlying impedance measurements by the radio-frequency bridge and the precautions to be taken in screening the apparatus. The second part deals with the apparatus used, such as valve generators, detectors and standards of capacitance, resistance and inductance. The last part treats about measurements on ultra short waves by "the stationary wave method".

The book under review has been written by a well-known experimental physicist who has devoted his life-time to the measurement of physical quantities, and is thoroughly conversant with all the practical difficulties in the experimental technique for Radio-frequency measurements. All this valuable experience, is presented in the book for the benefit of the student and the research worker.

A Mathematician's Apology. By G. H. Hardy. (Cambridge University Press), 1940. Pp. 93. Price 3*sh.* 6*d.*

This is a small book of about 100 pages written by one of the foremost mathematicians of England. The book gives stimulating discussions of some points about mathematics which appear very intriguing to a layman. One may not however agree entirely with the author about the necessity of an apology. For *e.g.*, when he says, p. 78, "The mathematics which can be used 'for ordinary purposes' by ordinary men is negligible ...." one can point out that in these times, *e.g.*, electrical appliances are in such ordinary use by ordinary men and the mathematics behind their design is by no means negligible. K. V.

Symmetric Functions in the Theory of Integral Numbers. By H. Gupta. (Lucknow University Studies No. 14), 1940. Pp. 105.

This is the 14th number of *Lucknow University Studies* being a course of lectures delivered by the author at Lucknow. The book contains an intensive study by the author of some problems in elementary theory of numbers. The first three chapters give a good introduction to the residue classes, primitive roots of a number and forms a good readable matter for the Honours students of our universities. The rest of the book deals with identities which are generalisations of the more elementary theorems such as Fermat's and Wilson's theorems, etc. Some theorems about the properties of Bernoulli's numbers are also dealt with.

The book is warmly recommended to all the college libraries. K. V.

Common Food Fishes of Shanghai. By Bernard E. Read. Published by the North China Branch of the Royal Asiatic Society, 20 Museum Road, Shanghai, 1939. Pp. 52, figs. 33 (1939).

In the last July issue of *Current Science*, attention was directed to a very valuable publication entitled "Common Marine Food-Fishes of Hong Kong" by G. A. C. Herklots and S. Y. Lin and hope was expressed that the authorities interested in the development of Indian fisheries would bring out similar pamphlets dealing with the important food-fishes of the principal towns of the country. Recently another similar work dealing with the "Common Food Fishes of Shanghai" by Bernard E. Read has reached the reviewer's hands. Though the descriptive part, containing an account of 31 fishes and a cuttle fish, is drawn up on the same plan as in the work of Herklots and Lin, in the other parts more attention is paid to the relative food values of different species by including tables of vitamin contents and of analyses of each of the 65 species into edible part by weight; protein, fat and ash by percentage; and lime, phosphorus and iron by quantities in milligrams. A list of 35 more species is also appended so as to include all the common fish of the Shanghai market. The author has thus embodied in this work a considerable amount of extremely valuable information based on highly technical researches on the protein, fat, mineral salts and vitamin contents of the principal food fishes of Shanghai. The information detailed in this work will be helpful in solving the nutrition problem, especially of the people of the various countries of the Indo-Pacific Region where the same or allied species of fishes occur.

There is one labelling error in an otherwise excellent work to which attention may be invited. In the figure showing the topography of a fish opposite page 5, the author has not correctly indicated the extent of the snout. The snout is the portion of the head in front of the anterior margin of the orbit.

S. L. HORA.

SYNTHETIC MOTOR FUELS*

BY

DR. J. C. GHOSH

(Director, Indian Institute of Science, Bangalore)

THE technique of warfare has been revolutionised in the last decade. Machines decide the fate of battles more than anything else. And they are mostly fitted with internal combustion engines which use petrol in large quantities. A fighter plane of the Hindustan Aircraft Co., develops 1000 H.P. in ten cylinders and consumes more than 200 gallons per hour. Ample supply of petrol is therefore an integral part of a defence programme. In Germany, which has no natural resources in mineral oil, synthesis of petrol has received very considerable attention; and in 1937, she produced 1·4 million tons of motor fuel from her factories as against her consumption of 2·5 million tons. This synthetic fuel was constituted as follows:—Coal tar benzene 300,000 tons, power alcohol 150,000 tons; Fischer-Tropsch oil 150,000 tons and Bergius oil 800,000 tons. Coal tar benzene and power alcohol which are bye-products of other industries cannot obviously be depended upon to yield all the motor fuel requirements of a progressive country. In India, a beginning has been made in the production of benzene from coal tar and of power alcohol from waste molasses; and vast developments in these fields should be possible.

The Bergius process consists in the conversion of coal, tar and creosote into oil by hydrogenation under pressures of 200–700 atm. and temperature of 400–500° C. Use of catalysts like oxides of molybdenum and tin has recently helped to make the operating conditions less severe. The Fischer process, on the other hand, has the merit that the operating conditions are very simple; a mixture of carbon monoxide and hydrogen, in the ratio of 1: 2 is passed over a catalyst at temperatures not exceeding 220° and pressures not exceeding 15 atm. More often a pressure of 1 atm. and a temperature of 185° are employed. In view of this simplicity of operation, the Fischer process is making rapid strides and bids fair to cast into shade the older Bergius process.

The complete Fischer process consists of three parts:—(1) Preparation of synthesis gas ($CO:H_2$ as 1:2), (2) Conversion of synthesis gas into higher hydrocarbons and (3) Processing of these hydrocarbons into motor fuel.

Synthesis gas is now prepared by enriching water-gas ($CO:H_2$ as 1:1) with hydrogen. Considerable economy has been effected in recent years in Germany in the manufacture of water-gas and hydrogen. For example, instead of transporting coke from a coke-oven plant to a water-gas plant where it is converted into water-gas by the action of steam at 1000° C., the German technicians have developed the practice of making water-gas *in situ* by the action of superheated steam on the coke as it is discharged from the coke-oven furnace operating at a temperature of 1200°. Since the ultimate object is to completely gasify the coke into water-gas the very much cheaper brown coal is now used in Germany which yields from the coke-ovens a porous solid fuel capable of much quicker gasification. Hydrogen is manufactured now in a continuous process with the aid of oxygen obtained as a bye-product from the synthetic ammonia industry according to the following simultaneous reactions:—

$$C + O_2 = CO_2 = 98{,}000 \text{ Cal.};$$
$$C + 2H_2O = CO_2 + 2H_2 - 19{,}000 \text{ Cal.}$$

If, as in the Lurgi process, the reactions are carried out at a pressure of 10 atm. the carbon dioxide is removed when blowing off the condensed steam, and hydrogen is obtained ready for the enrichment of water-gas. It is claimed that synthesis gas is now produced in Germany at 0·6 Pfg. per m^3.

The catalysts used in the Fischer process consist generally of suitable mixtures of two or more of the carbonates of the following metals:—Cobalt, Copper, Nickel, Iron, Manganese, Thorium. It is expected of the catalyst to selectively disrupt the bond between C and O in carbon monoxide, favour the reaction between this O atom and H_2 to form water, and the reaction between the Carbon with H_2 to form the radical CH_2, which in its turn yields $(CH_2)_n$ or C_nH_{2n+2}. The preparation of such a catalyst is even now more of an art than a science; and Fischer's frank statement will be appreciated by all workers in this line:—"After Dr. Tropsch had left me in 1928 in order to found the *Czechoslovakian Institute of Fuel Research* at Prague, it took another six years before Koch, Meyer and I could again produce catalysts of high activity."

The catalysts are kept in vertical cylindrical convertors with arrangements for water cooling, and synthesis gas gives an end product which has the following composition:—

Yield in Grams per m^3 of Synthesis Gas

Paraffin Wax	Oil above 200°	Gasoline Fraction below 200°	Gaseous hydrocarbons more than 50% C_3 and C_4
15	43	73	50

The processing of these Fischer end products to produce gasoline follows the same lines as those developed by petroleum technologists in America. It is the peculiar merit of the Fischer

* A synopsis of a lecture delivered in the Chemistry Colloquium of the Indian Institute of Science on 11-11-1941.

process that C_3 and C_4 hydrocarbons preponderate in the gaseous products. Their conversion into polymer gasoline by the Ipatief method is quite simple and almost quantitative. These gasolines have very high octane numbers and are prized as aviation petrol. The oil boiling above 200° is processed for Diesel oil, and the residue is subjected to catalytic cracking to yield hydrocarbons which are again converted into polymer gasoline.

Fischer plants in Germany were responsible for production of 150,000 tons of oil in 1937, 600,000 tons in 1938 and 1,000,000 tons in 1939. It is not known what progress has been made during the war. Japan placed orders for 3 Fischer plants from Koppers Co. of Essen in 1938, and their erection was completed in 1939. The question of the cost of production of light motor spirit by the Fischer process was gone into carefully by the Imperial Defence Committee of Great Britain. The estimate came up to 11*d.* per gallon which is not much different from the cost of production of the I.G. Farben-industrie—about 10*d.* per gallon. Before the War of 1914, Germany imported all her requirements of nitre from South America. In 1934, she was producing 1·2 million tons of fixed nitrogen, much of which she was selling abroad at Rs. 350 per ton of fixed nitrogen. It is probable that this war may do for the synthetic motor fuel industry what the last War did for the synthetic nitrogen industry.

The mineral oil resources of India are meagre —small deposits are being worked in Attock and Assam. Following the example of some enlightened European countries, she should insist that mineral oil should be imported in the crude state and refined within her borders. Such refineries in addition to providing employment for skilled labour, will be producing as bye-products, fine chemicals and solvents which are essential for her industrial development. A fuel research organisation with very well-equipped laboratories and financed on a generous scale is one of the crying needs of the hour. We understand that such a project is receiving the attention of the *Board of Scientific and Industrial Research* and we hope that early steps will be taken to bring it into being.

CENTENARIES

Kuhn, Adam (1741-1817)

ADAM KUHN, an American botanist and physician, was born at Germantown, Pa, November 17, 1741. Having studied medicine under his father, he went to Sweden in 1761 to study medicine at the University of Upsala.

There he became a student of Linnaeus. He carried to his professor a new plant of North America in a living state. It belonged to the family compositæ. The professor named it after his pupil and thus Kuhn was immortalised in botanical nomenclature.

From Upsala, Kuhn went to London in 1764 and thence to Edinburgh where he became M.D. in 1767. There his botanical interests were strengthened by his association with John Ellis. Kuhn returned home in 1768 and became professor of botany and materia medica in the College of Philadelphia. He was one of the founders of the College of Physicians of Philadelphia. He was also the first professor of botany in America.

Kuhn died at Philadelphia July 5, 1817.

Foster, Frank Pierce (1841-1911)

FRANK PIERCE FOSTER, an American dermatologist, was born in Concord, November 26, 1841. At the age of 15 he underwent an operation on his right arm and this made him choose his profession. He took the M.D. degree in 1857 from the College of Physicians and Surgeons of New York. He spent a year as a ship's surgeon cn a Pacific mail steamer. During his voyages he used his leisure hours in studying German. This scholarship was so kept up by him that he was selected in 1900 to re-edit Adler's *German-English dictionary* (1902).

Having served a while in the army, he settled in New York in 1865. At first he practised general medicine but later specialised in gynæcology. An ingenious method of extracting the fœtus after transverse presentation bears his name.

Still later he specialised in dermatology. Having witnessed the abuses of the then universal practice of arm-to-arm vaccination, he became an earnest propagandist for the use of animal lymph and introduced the manufacture of animal vaccine into America in 1871. He established a vaccine farm which brought him much money. In 1872 he won a prize for his thesis on animal vaccine and in the next year, the British Medical Association invited him to deliver an address on the same subject.

In the seventies he was librarian of the New York Hospital. In 1880, he became editor of the *New York medical journal.* His *Illustrated encyclopœdic medical dictionary* (1888–94), 4V., which was translated into four languages engaged him for twelve years. He was also the editor of the *Reference handbook of practical therapeutics* (1896–97), 2 V. As chairman of the Commission appointed by the American Medical Association to revise the medical nomenclature, he wrote the reports published in 1909, 1910 and 1911.

Foster died of cancer of the throat at Chadwick, August 13, 1911.

S. R. RANGANATHAN

University Library,
Madras.

SCIENCE NOTES AND NEWS

The Effect of Metallic Compounds on Some Grignard-Carbonyl Interactions.—While studying the mechanism of Grignard reactions, Kharasch and others (*J. Amer. Chem. Soc.*, 63, 2305) have investigated the catalytic effects of several metallic compounds. The benzophenone-isobutyl magnesium bromide interaction which normally yields benzohydrol, is practically unaffected in presence of cuprous chloride; but manganous chloride yields increasing amounts of benzopinacol and less of benzohydrol. Chromic and ferric chlorides are similar in action to manganous chloride but less effective. The yield of trichloroisopropanol and trichloroethanol in the chlorol methylmagnesium bromide interaction is somewhat reduced by cuprous chloride but increased by manganous chloride and metallic manganese. This interaction is inhibited to a large extent by ferric chloride. Further investigations in this interesting field will no doubt throw more light on the control of Grignard reactions.

M. R. A.

Splenectomy and Immunity of Rats to *Nippostrongylus*.—Except for an enlargement of the spleen in cases of infections like Trichinosis, Scistosomiasis and Ancylostomiasis, no attempt has been made to determine the influence of the spleen in relation to natural and acquired resistance to metazoan parasitic infections, and Yutuc's study (*Phil. J. Sci.*, 1941, 75) on the effect of splenectomy on the natural and acquired resistance of rats to *Nippostrongylus muris* is therefore the first work where a correlation between the two is attempted. Curiously the results show that splenectomy does not reduce the natural resistance of rats to *Nippostrongylus* infection. In fact, resistance appears to increase as a result of splenectomy as shown by the lower egg output, smaller worm burden and delay in the death of the rats. The production of immunity therefore is not influenced by the removal of the spleen where the operation was done before immunisation. Very slight reduction in immunity was noticed when splenectomy was performed after immunisation.

Plasticisers for Shellac.—The effects of various plasticisers on the different properties of the shellac film is described in Technical Paper No. 20 of the London Shellac Research Bureau, maintained by the Indian Lac Cess Committee.

In the present investigation, the London Shellac Research Bureau have examined about 30 plasticisers for the prevention of crazing, resistance to water and solvents, rate of drying, scratch hardness, flexibility and other properties. It has been found that no allround plasticiser can be recommended for shellac. However, when any one property is particularly desired in the resulting film, a plasticiser can generally be recommended for the purpose. Thus for ensuring water resistance, plasticisers like sextol phthalate, cyclohexanol tartrate and para-toluene sulphonamide may be used. When resistance of the film to the action of hydrocarbons is desired, the last two among a few others tested may be employed. In the same way, other plasticisers can be selected when resistance to scratch or a high degree of flexibility is the main consideration.

This investigation has brought to light several facts on the general behaviour of plasticisers towards shellac from a theoretical point of view. For instance, those plasticisers which were incompatible with shellac (like, for example, castor oil) were least effective. Mixtures of low-boiling solvents, when used for preparing the varnish, behaved better than when used singly, presumably due to the interlocking of these molecules and producing a different effect in the ultimate film. It was also found that, as may be expected, plasticisers containing hydrophilic groups were less effective from the point of view of the water-resistance of the film. In the case of the monester plasticisers, which are most often employed nowadays, the aromatic phthalates were superior to aliphatic phthalates in increasing the water-resistance of the film.

To an unusual degree, the production of photographic lenses involves the integration of physics, chemistry, mechanics and mathematics, and the difficulties are scarcely realised by the average purchaser of a photographic objective. In the first place, lenses are required for many specific purposes and a lens computed for one purpose rarely suffices for another. The designer has four variables with which he works: the properties of the glass, the curves of the surfaces, the thickness of the lenses and the spaces between them. He is confronted with a series of conflicting conditions, and the final result must necessarily be a compromise since all the aberrations cannot be fully corrected. The modern photographic objective is indeed composed of a number of elements rarely less than four and frequently eight, depending on its type. A lucid and fully illustrated account of the various aspects of making photographic objectives is given by E. W. Melson (*Bausch & Lomb Optical Company*) in "Photo Technique" of July 1941.

Industrial Research in Hyderabad.—For the promotion of industrial research in the State

a new organisation—the Scientific and Industrial Research Board,—has been recently inaugurated. An initial Government grant of Rs. 25,000 is announced for undertaking research on problems having immediate and direct bearing on the development of industries in the Dominion. The Board will carry on its work through eight research Committees. The number of such committees will be increased, if and when the need arises and their services will be available for private industrialists who may refer their problems to them for expert opinion.

National Institute of Sciences of India.—At a meeting of the Council of the National Institute of Sciences of India, held on Thursday, the 6th November 1941, in the rooms of the Royal Asiatic Society of Bengal, Calcutta, the following gentlemen were declared to have been elected Fellows of the Institute:—

Ordinary Fellows.—Dr. J. K. Basu, M.SC., PH.D. (Padegaon). Dr. Ram Behari, M.A., PH.D. (Delhi). Dr. H. J. Bhabha, F.R.S. (Bangalore). Dr. N. L. Bor, M.A., D.SC., F.L.S. (Dehra Dun). Dr. B. B. Dikshit, M.B.B.S., PH.D., M.R.C.P., D.P.H. (Bombay). Dr. P. K. Ghosh, M.SC., D.I.C., D.SC. (Calcutta). Prof. G. S. Ghurye, M.A., PH.D. (Bombay). Prof. B. C. Guha, D.SC. (Calcutta). Dr. R. C. Majumdar, DR.PHIL.NAT. (Calcutta). Dr. S. C. Mitra, M.A., D.PHIL. (Calcutta). Dr. S. R. Savur, M.A., L.T., PH.D. (Bombay). Prof. R. C. Shah, M.SC., PH.D. (Bombay). Prof. B. N. Singh, M.SC., D.SC. (Benares). Mr. V. P. Sondhi, M.B.E., M.SC., F.G.S. (Calcutta).

Honorary Fellows.—Dr. E. B. Bailey, F.R.S., Director-General, Geological Survey of Great Britain. Prof. E. S. Goodrich, M.A., D.SC., F.R.S., Linacre Professor of Zoology and Comparative Anatomy, Oxford University. Major M. Greenwood, D.SC., F.R.C.P., F.R.S., Professor of Epidemiology and Vital Statistics, London School of Hygiene and Tropical Medicine. Prof. E. O. Lawrence, Radiation Laboratory, California University, Berkeley, U.S.A.

University of the Punjab.—The appointment of **Dr. A. N. Puri** as Professor of Physical Chemistry in the University of the Punjab has been announced. Dr. Puri has had a brilliant academic career and has more than 100 papers on Soil Science to his credit. Soil Scientists are familiar with various types of apparatus devised by him, such as Puri Siltometer and Puri Chaino Hydrometer for the mechanical analysis of sands and soils respectively. He is well known for his work on the mechanical analysis of soils and studies in soil colloids and base exchange.

Dr. Bashir Ahmed has been appointed Professor of Organic Chemistry in the University of the Punjab. After undergoing post-graduate training, first in the University Chemical Laboratories, Lahore, and later in the University College, London, he was appointed Assistant Professor of Biochemistry and Nutrition in the All-India Institute of Hygiene and Public Health, Calcutta.

In 1937, Dr. Ahmed was awarded a Fellowship of the Rockefeller Foundation, New York. During this fellowship he spent one session at the Johns Hopkins University with Professor E. V. McCollum and six months at the University of Cambridge, Great Britain. The fellowship afforded him an opportunity for extensive travel in America and Europe, during which he visited renowned centres of chemical research in no less than 66 different universities and organisations.

Dr. Ahmed has published some fifty research papers in different fields of chemistry and biochemistry. His main field of research has been the subject of Vitamins to which he has made valuable contributions.

MAGNETIC NOTES

The month of September 1941 was on the whole less active than the preceding month. There was one day of *very great* disturbance, 5 days of *moderate* disturbance, 18 of *small* disturbance and 6 *quiet* days as against 2 days of moderate disturbance, 19 of small disturbance and 9 quiet days during the same period of 1940.

The day of largest disturbance was the 18th when a severe magnetic storm was recorded. The quietest day during the month was the 6th. The day-to-day classifications of characters is shown in the table below:

Quiet days	Disturbed days		
	Slight	Moderate	Very great
3 to 6, 27, 30	1, 2, 8 to 12, 15 to 17, 21 to 26, 28 & 29	7, 13, 14, 19 & 20	18

There were 3 storms, two of moderate intensity and one of very great intensity during the month as against a moderate storm recorded during September of last year. A detailed description of the storm of very great intensity which occurred on the 18th September 1941, has already appeared.[1] The monthly mean character figure for September 1941, is 1·00 as against 0·77 for September 1940.

October 1941 was on the whole much less active than the previous month. There were 16 *quiet* days, 12 days of *slight* disturbance and 3 of *moderate* disturbance as against 10 quiet days, 19 days of slight disturbance and 2 of moderate disturbance during October 1940.

The most disturbed day during October 1941, was the 31st while the day of least disturbance was the 3rd. Classification of individual days was as shown in the following table:

[1] *Curr. Sci.*, 1941, **10**, 432.

Quiet days	Disturbed days	
	Slight	Moderate
1-7, 13, 17-19, 25, 27-30	8-10, 12, 14-16, 20, 21 23, 24, 26	11, 22, 31

Three moderate disturbances were recorded during October 1941 as compared with one moderate storm during October of last year.

The mean character figure for the month was 0·58 as against 0·74 for October 1940.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Sun will be at the winter solstice on December 22.

Planets during December 1941.—Mercury is a morning star until December 22 when it reaches superior conjunction with the Sun; it will be rather too close to the Sun to be seen this month. Venus continues to be a superbly brilliant object in the western sky soon after sunset. It is getting rapidly brighter and will be at its greatest brilliancy on December 29, its magnitude at the time being —4·4. It should be possible to see the planet even in full daylight. Mars, although fading in brightness, will still be a fairly prominent object with a reddish colour (magnitude —0·5) very near the meridian in the early part of the night.

Jupiter which will be in opposition to the Sun on December 9, can be seen nearly all night during the month. Its magnitude when brightest will be —2·4, *i.e.*, more than twice as bright as Sirius, the brightest star in the heavens. Saturn will, likewise be a fairly bright object in the eastern sky in the early part of the night. Both Saturn and Uranus are near each other and move slowly in a retrograde direction in the constellation Taurus.

The well-known meteoric showers named the Geminids are due to appear in the second week of December. The dates of maximum display are December 11–12 and the position of the radiant point is given by R.A. 110° Declination 33° North very near the interesting double star Castor (α-Geminorum). The meteors of this group have generally swift short paths and their colour is white.

T. P. B.

SEISMOLOGICAL NOTES

During the month of October, 1941, ten slight and one moderate earthquake shocks were recorded by the Colaba seismographs as against one great, six moderate and two slight ones recorded during the same month in 1940. Details for October, 1941, are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
October 1941		H.	M.	(Miles)		(Miles)	
3	Slight	19	48	2620			
5	Slight	12	35	4930			
8	Slight	10	54	4400			
8	Slight	20	54	2100			
9	Slight	00	41	1930			
13	Slight	03	20	1270			
24	Slight	02	34	1490			Epicentre probably located near the Andamans
27	Slight	21	08	3280			
29	Slight	06	28	2130			Epicentre probably located near Sumatra
29	Slight	13	13	760	Probable epic.: Lat. 26°·6 N., Long. 63°·5 E., in Baluchistan		
31	Moderate	12	01	1760	Epic.: Lat. 25° N., Long. 100° E., in Yunnan Province, China		

ANNOUNCEMENTS

The Twelfth Conference of the Indian Mathematical Society will be held at Aligarh, under the auspices of the Muslim University, on 27, 28 and 29 of December 1941.

The Reception Committee at Aligarh has been constituted as follows: Dr. Sir Zia-ud-din Ahmad, M.A. (Cantab.), M.L.A., Vice-Chancellor, Muslim University, Aligarh (*President*); Prof. A. M. Kureishy, M.A., Head of the Mathematics Department and Provost (*Vice-President*); S. M. Kerawala, Esq., M.A. (Cantab.) (*Secretary*); Abdulla Butt, Esq., M.A., B. A. Siddiqi, Esq., M.A. (*Joint Secretaries*); O. R. Sherwani, Esq., M.A., Treasurer, Muslim University (*Treasurer*).

As the University is making arrangements for the boarding and lodging of visitors, all those who intend to attend the session are requested to write early to the local Secretary about the date and time of their arrival and whether they are vegetarians or non-vegetarians. It is hoped that all lovers of mathematics will attend the session and contribute to its success.

All-India Medical Conference.—The eighteenth session of the All-India Medical Conference will be held at Hyderabad (Deccan), on the 26th, 27th and 28th December 1941, under the kind patronage of H. E. H. the Nizam's Government. Dr. B. C. Roy, Dr. S. R. Moolgaonkar, and Dr. N. A. Purandare will preside over the deliberations of the Medical, Surgical and the Obstetrical Sections respectively.

An Industrial and Scientific Exhibition has been arragned.

The University authorities have kindly placed the University buildings at the disposal of the Conference. Intending visitors may communicate with Mr. Brijmohanlal, Osmania Medical College, Hyderabad, for further details regarding the Conference.

Indian Academy of Sciences.—The Seventh Annual Session of the Indian Academy of Sciences will be held at Nagpur on 24th, 25th and 26th of December 1941, under the auspices of the Nagpur University. There will be a Symposium on the Industrial Development of the Central Provinces and Berar, two popular lectures and meetings for the reading and discussion of scientific papers.

Essays in Anthropology.—Arrangements have been completed for the publication of the volume to be presented to Rai Bahadur Sarat Chandra Roy, M.A., B.L., F.N.I.

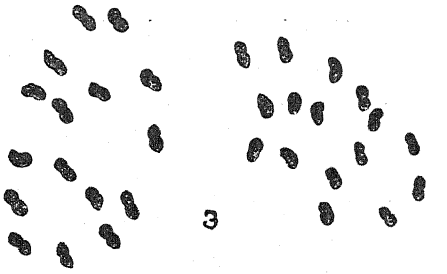
A limited number of copies are being printed on account of the high prices of materials.

The price of the volume has been kept at Rs. 12 and orders for copies should be sent early to Dr. D. N. Majumdar, Anthropological Laboratory, University of Lucknow, Lucknow.

The volume comprises contributions from:—

Mr. J. P. Mills, Dr. B. S. Guha, Dr. A. Aiyappan, Prof. K. P. Chattopadhya, Rev. Dr. Verrier Ellwin, Dr. D. G. Mandelbaum, Mr. P. G. Shah, Prof. Baron Von Furer-Haimendorfer, Mr. G. H. Archer, Mr. P. Kodanda Rao, Dr. E. W. Macfarlane, Mr. N. K. Bose, Rev. Stephen Fuche, Prof. A. Aiyar, Mr. W. V. Grison, Mr. David Roy, Prof. N. N. Sen Gupta, Prof. Radha Kumud Mukerjee, Prof. Radha Kamal Mukerjee, Rev. W. J. Culshaw, Dr. D. N. Majumdar and others.

It is regretted that on page 439 of Vol. 10, No. 10, Fig. 3 in the note entitled "Chromosome Number in *Sesamum prostratum* Retz.", by Dr. S. Ramanujam, was printed incorrectly with 16 and 14 chromosomes in the two anaphasic groups. The correct reproduction of the figure with 16 and 16 distribution is given below:—



We acknowledge with thanks, the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4592–94.
"Journal of Agricultural Research," Vol. 63, No. 1.
"Agricultural Gazette of New South Wales," Vol. 52, Part 9.
"Biological Reviews," Vol. 16, No. 3.
"Journal of Chemical Physics," Vol. 9, No. 9.
"Chemical Products," Vol. 4, Nos. 9–10.
"Experiment Station Record," Vol. 85, No. 2.
"Indian Forester," Vol. 67, No. 11.
"Transactions of the Faraday Society," Vol. 37, Part 8.
"Indian Farming," Vol. 2, No. 10.
"Review of Applied Mycology," Vol. 20, Parts 7 and 8.
"The Mathematics Student," Vol. 9, No. 2.
"Scripta Mathematica," Vol. 8, No. 1.
"The Indian Medical Gazette," Vol. 76, No. 10.
"Journal of Nutrition," Vol. 22, No. 3.
"American Museum of Natural History" (Journal), Vol. 48, No. 2.
"The Philippine Journal of Science," Vol. 75, No. 3.
Nature," Vol. 148, Nos. 3743–44, 3746–47.
"Indian Journal of Physics," Vol. 15, Part 4.
"Journal of Research," (National Bureau of Standards), Vol. 27, No. 2.
"Canadian Journal of Research," Vol. 19, No. 7.
"Science and Culture," Vol. 7, No. 5.
"Indian Journal of Veterinary Science and Animal Husbandry," Vol. 11, Part 3.
"Indian Trade Journal," Vol. 143, Nos. 1842–46.

BOOKS

"Text-book of Physical Chemistry," by Samuel Glasstone. (Macmillan & Co., London), 1940, pp. xiii + 1289.

"A Text-book of Electricity and Magnetism," by G. R. Noakes (Macmillan & Co., London), 1941, pp. x + 513. Price 8/6.

"A First Course in Algebraic Geometry," by B. B. Bagi, Dharwar, 1941, pp. vi + 264. Price Rs. 2-12-0.

"The Common Commercial Timbers of India and Their Uses," by H. Trotter. (Manager of Publications, Delhi), 1941, pp. iv + 234. Price Rs. 2 or 3/-.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

October 1941. SECTION A.—SIR C. V. RAMAN: *The quantum theory of X-ray reflection: Basic ideas.* SIR C. V. RAMAN: *Quantum theory of X-ray reflection: Mathematical formulation.* SIR C. V. RAMAN AND DR. P. NILAKANTAN: *Quantum theory of X-ray reflection: Experimental confirmation.* P. RAMA PISHAROTI: *A quantum theoretical explanation of the appearance of forbidden X-ray reflections in diamond.* DR. C. S. VENKATESWARAN: *Low-temperature studies in the Raman X-ray reflections in crystals.* Dr. C. S. VENKATESWARAN: *The quantum reflection and the quantum scattering of X-rays in rock-salt.* DR. C. S. VENKATESWARAN: *The Raman X-ray reflections in organic crystals, I. Naphthalene.* DR. C. S. VENKATESWARAN: *The Raman X-ray reflections in organic crystals, II. Benzophenone.* DR. C. S. VENKATESWARAN: *The Raman X-ray reflections in organic crystals, III. Hexamethyltetramine.* BISHESHWAR DAYAL: *X-ray reflections of the second kind in metallic crystals.* DR. C. S. VENKATESWARAN: *The Lattice spectrum and the Raman X-ray reflections by rock-salt.* P. RAMA PISHAROTI: *The absolute intensity of the Raman X-ray reflections in diamond.* P. RAMA PISHAROTI AND R. V. SUBRAHMANIAN: *On the multiple spots and streamers exhibited by the* (111) *dynamic reflections in diamond.* R. V. SUBRAHMANIAN: *On the Raman X-ray reflections in organic crystals. IV. Benzil.* P. NILAKANTAN AND P. G. N. NAYAR: *Quantum reflection of X-rays in calcite.*

SECTION B.—B. SUNDER RAJ: *Dams and fisheries: Mettur and its lessons for India.* BHOLA NATH SINGH: *The growth of the sugarcane plant in India, II. Physiological effects of deficiency or excess of added fertilisers upon growth characters, carbohydrate metabolism, yield, and juice quality of sugarcane.* D. MARUDARAJAN: *Observations on the production of sexual organs in paired cultures of phytophthora species of the palmivora group.* MAHESHWAR SINGH SOOD: *The caudal vertebræ of* Eryx johnii (*Russell*). T. S. RAMAKRISHNAN: *Studies in the genus* Colletotrichum. *II. Physiological studies on* Colletotrichum falcatum *Went.* T. S. RAGHAVAN AND A. R. SRINIVASAN: *Studies in rubiaceæ, II.* Spermacoce hispida *Linn.* Guettarda speciosa *Linn. and some cytomorphological considerations.* K. GANAPATHI AND R. SANJIVA RAO: *Action of sulphanilamide derivatives in experimental streptococcal and pneumococcal infections in mice, Part II.*

Royal Asiatic Society of Bengal:

November 3, 1941.—P. L. MISRA: *Observations on an intestinal flagellate,* Tetratrichomastix hegneri, sp. nov., *from the 'skipping frog',* Rana limnocharis *Meig.*

Society of Biological Chemists, India:

October 25, 1941.—C. N. BHIMA RAO, N. N. DE, M. V. LAKSHMINARAYANA RAO, M. S. RAMASWAMY AND V. SUBRAHMANYAN: *Chemical nature of insulin.* G. B. RAMASARMA AND D. N. HAKIM: *Absorption of minimal doses of carotene by experimental animals.* K. G. JOSHI: *Fixation, penetration and availability of phosphoric acid in grassland.* T. R. DORAISWAMY AND M. S. RAMASWAMY: *Rennin Analysis of gastric juice and its significance.*

1619-41—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the Board of Editors, "Current Science", Bangalore.

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SCIENCE AND ETHICS

THE symposium on the relations between science and ethics, published in *Nature* of September 6, is undoubtedly useful as well as interesting, though far from conclusive. In view of the present burst-up of civilization and the heart-searchings thereby caused, the subject is of immediate and universal interest. We may be sure it will not be claimed for the discussion in *Nature* that it has exhausted all possible points of view; and this article is intended to indicate another line of thought for examination by scientists. But we must first furnish a summary of *Nature*'s symposium.

Dr. C. H. Waddington, a biologist, has initiated the discussion with the thesis that "ethics is based on facts of the kind with which science deals;" that "science is in a position to make a contribution to ethics;" that science's contribution is "the revelation of the nature of the character and direction of the evolutionary process in the world as a whole, and the elucidation of the consequences, in relation to that direction, of various courses of human action". This thesis Dr. Waddington seeks to base on the findings of Psycho-analysts, Anthropologists, Marxists and Logical Positivists. Their findings are together taken to indicate that "all characters are both inherited and acquired; that they are products of the interaction between the genes, which we usually consider internal, and the equally necessary factors, such as oxygen, nourishment, etc., which we usually consider external"; "that the origin of the propositions of ethics is the observation that the world is such, and the personality is such, that the individual must follow certain rules". The super-ego within and conditions of existence without have till now

been responsible, jointly and leaving no room for any other factor, for our rules of conduct called morality, ("super-ego" being the name given by psycho-analysts to what they suppose to be a fetishistic power—a god, a conscience, or an indeterminate something which may be a complex of many things and derives authority not from the known world). "No criterion external to the natural world is required to decide what is the 'good' direction of the evolution" of society. "An existence which is essentially evolutionary is itself the justification for an evolution towards a more comprehensive existence."

We are afraid the lay reader must complain, as indeed many of the participators in the debate have done, that Dr. Waddington's method of presentation has not served to bring out his point, whatever it is, very clearly and precisely, or to make his argument compulsive. It is surprising that in formulating a new theory in a matter of such vital significance, Dr. Waddington should have, firstly, placed unqualified reliance on sciences which are still in experimental stages and very far from being definitive; secondly, omitted to check their evidences in the light furnished by the many other pertinent witnesses that there are, such as physicists and chemists on one side, and metaphysicians, normal psychologists, poets, theologians, historians and so forth on another. He has, in his book on *The Scientific Attitude* (pp. 62–63), admitted that science has not yet come to speak with a unitary voice, that her tongues are many and therefore confusing. It should have occurred to him that science would be assuming too much responsibility in trying, at this stage, to lay down final dicta on the ultimate questions of life and destiny. Indeed, his very first premise,—that "ethics is based on facts of the kind with which science deals,"—is not easy to grant. Facts of science are only a part of the universe with which ethics is concerned. There are other facts and factors of intimate concern to ethics which are not available to the microscope and the test-tube.

The Bishop of Birmingham raises questions as to the soundness of some of the fundamental assumptions of Dr. Waddington. He asks:—"If an external world exists, is our picture of it correct? ..... Are our scientific laws accurate?" His answer is that the ethical standards we employ are, like our supposed knowledge of the universe, partial and transitional. He asks in conclusion:—

"Are we wrong to find purposive activity behind the processes of change called evolution, to postulate God as its source, and to see in the ethical change which results from the growth of human experience His progressive revelation of Himself?"

The Dean of St. Paul's is even clearer in his dissent. He says:—If Dr. Waddington's point is that "the natural sciences have a valuable contribution to make to the study of ethics, few would deny it; if it is, as I think, the contention that the central problem for ethics can be solved by the method of natural science, that seems to me a disastrous error." The Dean's view is that "the moral experience in its authentic form is the opposite of compulsion" and that there is a responsibility of choice belonging to man. He is further of the view that there is "no reason to suppose that at any given moment, the actual direction of evolution is towards higher values", and

that "the voice of duty comes from a Source deeper and more intimate than the course of evolution."

Prof. W. G. deBurgh is categorical in his denial of the authority of the sciences relied upon by Dr. Waddington.

Biology knows nothing of the qualitative distinction of higher and lower, better and worse; it can only display the continuity in the modifications of species through descent. ..... The cosmic process is wholly amoral. ..... The scientific study of it cannot teach us what is good or what we ought to do..... It cannot tell us that what will be is right or good.

Prof. C. E. M. Joad adduces an evidence strangely ignored by Dr. Waddington.

The real agents of ethical change are to be found less in the factors of external nature or of economic motive (Marxism) than in the appearance of an ethical 'sport' in the shape of a Christ, a Buddha, a Socrates or a Blake who points the way to new levels of conduct and new standards of value.

Other dissentients from Dr. Waddington's view are Prof. L. S. Stebbing, Prof. A. D. Ritchie, and Prof. H. J. Fleure. Professor Stebbing says—"It is not compatible with Dr. Waddington's 'realist definition' of 'good' to speak of the course of evolution as morally offensive or morally admirable". Prof. Ritchie holds that by reason of its method, "the only values within the scope of science are truth and error as judged by logical consistency and conformity to fact." Dr. Waddington's theory "rests on *a priori* pre-suppositions, which it is best to be honest about" having regard to the limitations of the values of science just indicated. Prof. Fleure points to the unacceptability of Dr. Waddington's proposition that "to decide what is the 'good' direction of evolution, no criterion external to the natural world is required." Dr. Fleure's view is this:—

Man is a social being and, within society, there is an unceasing and not always successful struggle towards freedom of conscience, towards replacement of external by internal factors..... The survival value of this freedom is related to the facts of observation and inference ..... Life's history on earth has been a process of ever recurring readjustments; and, with few exceptions, the fate of those forms which did not readjust has been extinction..... These developmental adjustments are selective; if some features are enhanced, others are atrophied. So, it is not very wise to suggest that the latter include the earlier; that unduly simplifies the idea of change and suggests acceptance of the rather crude notion of the inevitability of progress.

The last contribution to the debate is that made by Prof. Julian Huxley, a biologist. He points out how sciences not taken into account by Dr. Waddington have contributed to the breakdown of traditional views on ethics.

Evolutionary biology is one of them with all its implications as to human ancestry, the struggle for existence and the abolition of the idea of purpose in evolution. All the physical sciences have contributed, by providing a mechanistic explanation of natural phenomena previously attributed to supernatural powers and often invested with an ethical aura.

He agrees that it is possible to develop a new ethic, and to extend the categories of moral duties, in the wake of the extension of knowledge of nature which science achieves. But Prof. Huxley does not accept the theory of super-ego as an explanation of "certain aspects of morality which are felt as a categorical imperative." These aspects of morality he would appear to attribute to repression in early life.

A great part of our ethical development will consist in demolishing the absoluteness

and compulsiveness of our early categorical imperatives and in altering the field to which they apply, in the light of reason and experience. ..... For constructive and truly humanistic ethics, we need to liberate psychological energies from the unconscious repression of early life, through reason and still more by appropriate education and by opportunities for fuller living.

On the whole, Prof. Huxley endorses Dr. Waddington's thesis that—

Ethical systems are indispensable social organs, derived from the impact of a changing external world on the minds of indivisuals *via* the social environment, but themselves then helping to effect changes in the external world and the social environment.

The discussion is of value as indicative of certain points of view. If it should have been more than that, one cannot help thinking that the writers ought to have been more lucid in their style, more comprehensive in their survey and more coherent in the marshalling of their arguments. One thing significant is that no one speaks in accents of certitude and no one seems to have anything positive to communicate. To say that they have adopted the tone of diffidence and are negative in their intimations is not to find fault with them, but rather to acknowledge that they are not lacking in frankness as to the limitations of their position. Bluntly stated, the position is that the data which science in its present state can furnish, including even the "exact" sciences, for a theory of ethics or metaphysics, are a field of quicksand. Nothing in science is now without an element of uncertainty. The laws of nature so far proved and established relate only to the upper strata of phenomena. That the ultimate questions are still a long way from a final and universally acceptable solution is proved, for example, by the controversy between Sir James Jeans and Sir Arthur Eddington in the pages of *Nature*, still being carried on over the meaning of a book by the latter published more than two years ago.* The lay student may perhaps hazard the remark that such inconclusiveness of science is its normal condition; that it cannot simply be helped; that science will indeed have ceased to be science when she has taken refuge in a dogma, and will have lost her occupation if she were ever able to feel that the journey's end has been reached and that there need be no more search by her; that she can serve us best only by remaining a diligent seeker and truthful reporter for all time. The best that she can ever hope to contribute is not definitive conclusion, but material,—verified and logically assembled material,—for some other agency to formulate conclusions thereupon so far as the deeper problems of life are concerned. Such problems are mainly the concern of ethics and metaphysics. They have constantly to re-examine their positions and correct them in the light of the evidences of science. The proper office of science is thus that of a witness; not that of the judge. When science assumes the role of the judge, it takes upon itself responsibilities for which it is not, according to its own admitted nature, fully equipped. When scientists have the frankness and the modesty to acknowledge this limited jurisdiction of their study, they will have ensured to science a

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* (1) "The Philosophy of Physical Science" by Sir A. Eddington. (Published in October 1939 by the Cambridge University Press.)

(2) *Nature*, August 2 and 30, 1941 (Nos. 3744 and 3748).

readier welcome into the court, and thereby enhanced her contribution to the making of philosophy.

The one point that emerges with general approval from the discussion in *Nature* is almost a commonplace. It is that ethics will be faced with new problems as science goes on creating new situations or disclosing new facts from beneath the covering of old situations, and that morals will have to go on evolving accordingly, as they have gone on in the past. In other words, science too has a part to play, and does play a very conspicuous part, in the evolution of morals. No one will dissent from this proposition. Science, indeed, is entitled to play such a part, and the people who deny this title to her will do so at grave peril to themselves.

But the fundamental question is:—Where is it that the moral sense has its origin? Is that sense merely the offspring of temporal calculations of convenience and comfort for oneself; or is it part of the essential nature of man—of that which constitutes humanness? Is it intrinsic or extrinsic? Which is the locus of the seed of morality? Is it the super-ego? Or is it external nature? Or is it a third something? Where so many earnest minds are busy inquiring and examining, we may perhaps be permitted to bring to their notice a view of life which is the most ancient view still living in the world, namely the Hindu view.

According to one school of the Vedantic philosophy, the whole universe is instinct with life-potential. This is in various stages of dormancy or of awakenedness. There never was a time when the life-potential did not exist, and there never will be. When this eternal life-potential manifests itself in man, it releases in him certain primary propensities or impulses (*vasanas*). In these impulses (*Samskara-vasanas*) brought forward from a previous state of existence of the man, lie hidden the forces of both altruism and egoism, of both social and anti-social behaviour. It is on this primary stuff that environment works. But the *vasanas* or impulses are not all alone. With them is associated a reasoning intelligence in shaping man's further career.

It is necessary to explain that a great many impulses or *vasanas* are a matter of inheritance, and that heirship itself is not a matter of accident, but one of inexorable law. A man's ancestry and also his environment including even what appear to be accidents, are determined by the logic of his previous incarnations. It is this inscrutable logic that is called the law of *Karma*. This explanation of the origin of *vasana* or impulse must obviously take us beyond the province customarily recognised by science as her own; it takes us to the land of the unprovable, the land of faith. Indeed, without the acceptance of the postulate of a *Tertium Quid* and its mysterious working, the philosophy of the Hindu would have no legs to stand upon.

Having postulated a mysterious Third Agent who, without revealing his own nature fully, enters into the life of man and of Nature, and having also postulated a law to explain ancestry and environment, the Hindu philosopher holds that man, nevertheless, has a range of freedom for his own discrimination and choice as to right action. The field of man's free action is bounded on the one side by the residual forces of his beginningless past, and on the other

side by the immeasurable forces of the cosmic sport behind which stands the Great One (*Brahman*). So situated, he has to find out that which is "good" by his own intelligence and achieve it by his own effort.

There is a duality in the composition of man: an outward impulsion and an inward impulsion. The flow and interplay of these two forces is human life. They mould character and make history.

The outward impulsion (*Pravritti*) takes the form of the thousand and one hungers of the body and the senses, and seeks their satisfaction from without. The investigation of the possibilities and potentialities of Nature and the ordering of collective life as family and State are the incidents of that outward impulsion. Thus arise science and politics and economics and art.

The inward impulsion (*Nivritti*) takes the subtler form of the hungers of what is called the soul—of the ego or the "I" element—and seeks satisfaction in the shape of answers to questions about man's ultimate destiny and about the purpose of life, if there be any. Thus arise religion and the non-utilitarian nucleus of morality—the instinct for justice and pity and righteousness, —and philosophy.

Of course the two impulses, as they proceed from a common centre, relate themselves to it constantly. They interact between themselves, leading to a mutual modification or intensification.

The outward urge, being the grosser and the more easily satisfiable, acts more quickly and more commonly than the other. The inward urge is ordinarily slower and less insistent.

Viewed from an absolute standpoint, the antinomy between the outward and the inward is a mere seeming; and beneath this seeming lies the reality of the *Tertium Quid* (the *Atman* or *Brahman*) transcending all; and the realization of it abolishes all distinction between the two,—between the subjective and the objective.

The way to the finding of this *Tertium Quid* is through a constant effort to reach a balance between the external concerns of life and the internal, a condition in which neither hunger is starved and neither interferes with the reasonable satisfaction of the other. The attainment of this state of harmonious adjustment of both departments of life under a higher control constitutes the central problem of ethics and philosophy. The higher control is to be looked for from a constant practice of the presence of the *Tertium Quid*. Both impulsions then become disciplines for the soul. Such an attitude and way of life is *Dharma* or ethics.

The fields of man's outward search are for ever bound to remain incapable of yielding unqualified or lasting satisfaction; and to fix the eye exclusively on them is to remain for ever discontented and chafing. Nature has so unequally distributed her gifts over the earth, our hungers are so manifold and so prolific, and our powers of obtaining satisfaction are so diverse and uneven that we must always be prepared to find some part or other of the human family to be aggrieved and complaining of maladjustment. Such grousing is in the very nature of Nature. Man owes it to himself,—to the ethicizing element called conscience in the introspective impulse within himself,—to strive

for the correction of social maladjustments partly by conquering more and more of Nature's resources for the use of mankind and partly by enforcing more and more equity in the distribution of the means of welfare among men. Indeed, such persistent striving for the improvement of human conditions,—by means, among others, of scientific advancement and social reform,—is the way of strengthening and developing that instinct of altruism in ourselves which is an indispensable vehicle for the realization of what we have called the *Tertium Quid*. But we should take care not to let our concern for the outward become a burdensome preoccupation, making us forget the inward duty and diverting us from the higher path.

The outward struggle, if it is not to lead us to a morass of unending turmoil and frustration and despair, should be under the inspiration and control of the aspiration inward. And the inward movement, if it is to proceed undisturbed towards fruition, should let the outward struggle so proceed that it could bring new supplies of spiritual strength by wearing out the "I" sense and developing the sense of the "All". From individualism to universalism in practice is the way to the realization within the soul of the oneness of the individual with the universal—a realization which is not simply an intellectual or emotional accomplishment, but a transmutation of man's whole spirit.

To be alive both in and out; to bring the outward and the inward into harmony; to so regulate the outward that the inward may not become a void, and so develop the inward that the outward may not remain a burden—that is true culture and true progress. This is the central principle of right conduct or *dharma*. The forms of *dharma* are many. They grow and develop so as to fit circumstances. But the governing motive is approach towards the Brahman.

Dharma literally means "the bearer" or "the upholder". *Dharma* is that which upholds or supports life by making it good. It is to be applied to the entire field of life—both individual and collective, and relating both to the mundane and to what is other than mundane. Of the all-comprehensive scheme of *dharma*, what in English is called morality is an integral part. Morality is ordinarily conduct that affects others. But there are also parts or aspects of conduct which do not concern others, but concern oneself most intimately—one's own character and one's own mind. Even in these 'private' departments of conduct, there is need for *dharma* or correct principles. If one should realize throughout one's life—in every detail and at every point—that harmony and communion between the inner and the outer departments of life which is the *summum bonum* for man, it is imperative that one should constantly put oneself under a reasoned discipline. The less spiritual elements of one's nature should, partly by restraint and partly by persuasion, be trained into subordination to the more spiritual. This implies discriminating attention not only to the needs of the body, but also to the needs of the æsthetic and the intellectual sides of life. No human faculty need be famished provided it will be governed by *dharma*. Indeed it is conceivable that *dharma* may itself recommend that certain appetites should be kept satisfied

upto a point, so that the higher elements in the man's nature may be left at peace to develop and grow.

Dharma has a particularistic side as well as a universal side. The great laws of society and State including custom, convention, formality and etiquette are of the latter category. Under the former head, the general rules are to be interpreted or modified so as to suit peculiarities of individual circumstance (*Dharma Sukshma*). Striving to maintain the social order, to improve conditions of existence, to cultivate fortitude, to face misfortune, to seek and find joy in life;—study, struggle, adventure, achievement;—all these can be an experience and an education to the human spirit; and *dharma* therefore should direct and control them all.

The seed of *dharma* lies imbedded within the nature of every man, besides the *vasanas*. It is part of his very nature. It is Wordsworth's "stern Daughter of the Voice of God". It is quickened into life by intelligence, education and reason; and the freedom to bring his intelligence to its aid and service belongs also to man.

The end of *dharma* is the complete and uninterrupted possession of the vision of the unity of life—the unity underlying life's myriad forms and myriad aspects and running through all processes of growth and change. He who has in his soul captured the vision of this infinite and indivisible unity has outgrown self-consciousness. He knows neither "I" nor "you" nor "he". Everything is the All or One to him, his sense of his own "self"—*i.e.*, his own distinctness,—being lost in it. How can his activities thereafter be other than "good"? He is good without effort, because he has rid himself of the taint of "I". Loving kindness would ever flow from him spontaneously, like the breath in his nostrils. *Dharma* is the scheme of duties and disciplines which leads man to become merged in this grand unitary vision of the ceaseless cosmic play. So to lose one's self is to gain the peace of "the eternal deep".

Such in rough outline is the Hindu's conception of right conduct. Would Dr. Waddington trace it to biological evolution or economic history or psycho-analyst super-ego? The Hindu view can be sustained only if the postulate of a *Tertium Quid* besides Man and Nature be accepted; and if there is anything in science to preclude such a postulate, the ground of that preclusion has nowhere been made clear. Science may not herself need it; but life, which is larger than science, stands in need of it if it should be more than a race of blind mice terrified by the screams of lame cats themselves frightened by the sniffings of dumb dogs in a sunless wood.

Matthew Arnold has summed up the argument, as a philosophical poet would, in some lines addressed to a preacher:—

"In harmony with Nature? ' Restless fool
Who with such heat dost preach what were to thee,
When true, the last impossibility!—
To be like Nature strong, like Nature cool!
Know, man hath all which Nature hath, but more,
And in that *more* lie all his hopes of good.
Nature is cruel, man is sick of blood;
Nature is stubborn, man would fain adore;
Nature is fickle, man hath need of rest;
Nature forgives no debt, and fears no grave;
Man would be mild, and with safe conscience blest.
Man must begin,—know this,—where Nature ends;
Nature and man can never be fast friends.
Fool, if thou canst not pass her, rest her slave."

D. V. G.

ATOMIC VIBRATIONS IN CRYSTALS

BY

SIR C. V. RAMAN

THE theory of the specific heat of crystalline solids is considered from a new standpoint in a symposium of seven papers appearing in the *Proceedings of the Indian Academy of Sciences*, for November 1941. The introductory paper is contributed by the author and is followed by six papers in which the basic ideas there outlined are successfully applied to the explanation of the experimental data for numerous substances of relatively simple composition. The cases of diamond and white phosphorus are considered respectively by Mr. V. B. Anand and Mr. R. Norris. Mr. Dayal has two papers on the specific heat of metals crystallising respectively in the cubic and hexagonal systems. Dr. C. S. Venkateswaran considers the case of the alkali halides in a specially thorough fashion, while Mr. R. Norris discusses the data for crystalline quartz.

As is well known, Einstein laid the foundations of the quantum theory of specific heats in his classic paper of 1907 in which the specific heat anomaly presented by diamond was explained on the assumption that the atoms in the solid vibrate with a high characteristic frequency. At low temperatures, however, the specific heat of all elementary solids falls off less rapidly than is indicated by the Einstein formula if a single characteristic frequency be assumed.

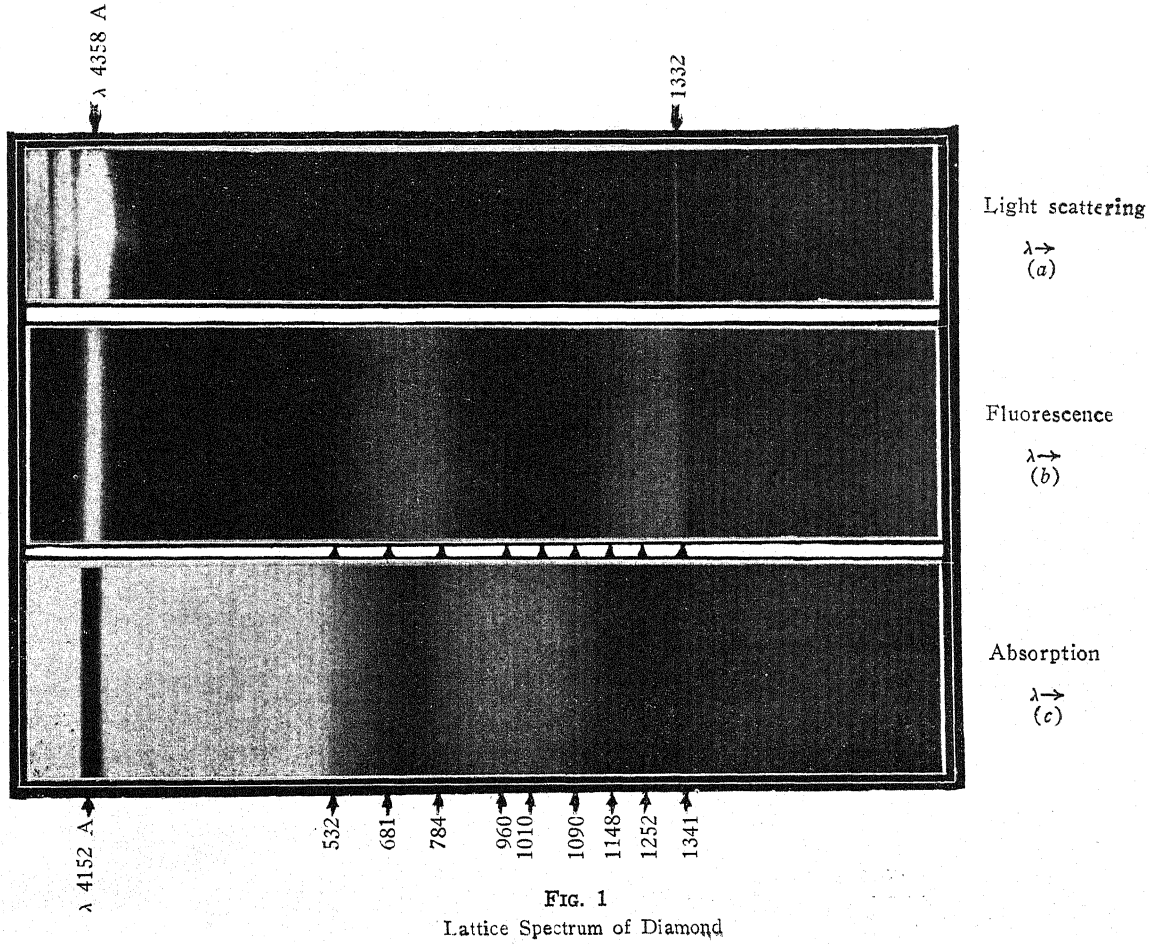

FIG. 1
Lattice Spectrum of Diamond

This was regarded as indicating a failure of the Einstein theory and led to its falling into disfavour. Discussions of the thermal energy data are at present usually based on the alternative theory propounded by Debye which derives its inspiration from the classical mechanics of vibrating elastic solids. Debye disregarded the discrete atomic structure of solids and assumed the atomic vibrations to be identical with the elastic modes of a continuum having various frequencies up to a suitably assumed high limit. An alternative form of the theory developed by Max Born and his school formally takes account of the crystal structure but has as its basis the so-called "postulate of the cyclic lattice". This postulate assumes that the external boundary of the solid determines all the possible modes of atomic movement exactly in the same way as in the classical theory of elastic vibration. The theories of Debye and Born are thus both based on an extrapolation of ideas derived from macroscopic physics into the field of atomistics. Such an extrapolation, besides being theoretically indefensible, leads to results which stand definitely contradicted by the experimental facts in many fields of inquiry. It is sufficient here to mention one example, namely the results of spectroscopic study of the scattering of light in crystals. Such studies show clearly the correctness of the original hypothesis of Einstein, namely that the atomic vibrations in crystals have *monochromatic frequencies*. Numerous sharply defined lines are recorded in the spectrum of monochromatic light diffused by transparent crystals, the frequency shifts observed being both greater and smaller than the so-called "limiting frequency" calculated from the elastic data (see Fig. 1).

The proper approach to the problem of atomic vibrations in crystals is evidently *not* from the macroscopic point of view, but from atomistic considerations which take as their starting point the known periodic space-grouping of the ultimate particles in the solid. What are the departures from the static grouping in space which are dynamically possible and what are their frequencies? In seeking an answer to these questions, we are justified, in view of the very fine scale of the atomic structure, in ignoring the existence of an external boundary and considering the solid to be of unlimited extension. On this assumption, it follows that the possible vibration patterns must be simply related to the architecture of the crystal. Any departure from the static grouping of the atoms will repeat itself with perfect periodicity in time only if it be also perfectly recurrent in space, in other words, only if the vibrations occur in identically the same fashion throughout the solid. The unit "cells" of the dynamic pattern must thus be either identical with the lattice cells of the crystal or else must embrace an integral number of such cells, thereby forming a superlattice. In other words, the atoms throughout the crystal occupying equivalent positions in the lattice or superlattice cells should oscillate in the same way. Such an oscillation would have a perfectly defined frequency, and the number of such frequencies would be determined by the number of atoms contained in each lattice cell or superlattice cell as the case may be. The larger the cell of the superlattice, the more completely would such an analysis (carried out in detail by the methods of the group theory) represent all the possible modes of atomic vibration in the crystal.

For the detailed development of these ideas, the reader may be referred to the papers appearing in the symposium. The thermal energy content of most crystals at ordinary temperatures depends almost exclusively on the modes of vibration which may be found by considering dynamic repetition patterns in which the space unit is the smallest which is fully representative of the structure and symmetry of the crystal. Even so, there would usually be several Einstein frequencies requiring consideration. In some cases, *e.g.*, diamond, phosphorus, alkali halides and quartz, these frequencies and the weights to be attached to them may be ascertained from the spectroscopic data and the known crystal structure. In other cases, *e.g.*, the metals, the specific heat data have themselves to be utilized to supplement the information furnished by considerations of crystal structure.

The principal lattice frequencies represent the movements of the atoms within the unit cell relatively to each other. They necessarily include the internal vibrations of any ions or molecules present in the lattice, as also the frequencies of their hindered translations and rotations. The superlattice vibrations which appear in the theory may be pictured as representing the oscillations

of neighbouring lattice cells or groups of lattice cells against each other. Such oscillations are necessarily of lower frequency and of lower statistical weight than the principal lattice frequencies. The contribution which they make to the specific heat would be sensible only at low temperatures, except in the case of crystals of very simple composition where they may have to be taken into consideration even at ordinary temperatures. The superlattice oscillations are the nearest analogue in the present theory to the elastic vibrations of macroscopic physics, but differ from them in being precisely related to the crystal structure and in possessing specifiable frequencies. That the existence of such vibrations is a physical fact and not a mere hypothesis is evident from the spectroscopic data for various actual crystals, *e.g.*, diamond (see Fig. 1).

The most significant point which emerges from the symposium is that the experimental facts in several cases which refused obstinately to fit into the Debye and Born theories find a natural explanation in the new theory without the aid of any special hypotheses.

RADIO RECEPTION DURING THE MAGNETIC STORM AND IONOSPHERIC DISTURBANCE FROM 17th SEPTEMBER TO 20th SEPTEMBER 1941

BY

K. VENKATARAMAN

(*Research Department, A.I.R.*)

SHORT WAVE radio services were very badly affected during the period 17th to 20th September 1941, due to a magnetic storm of severe intensity lasting for several hours and three sudden but short fadeouts of the Dellinger type. As published radio data from India on this subject is rather scanty and as such information may be useful for correlating world-wide conditions, it is proposed to present here the conditions of radio reception as reported by the various Receiving Centres of A.I.R. distributed throughout India, together with the results of pulse observations made at the main Receiving Centre at Todapur near Delhi.

The times of occurrence of the disturbances as far as can be estimated from *radio observations* are given below:—

(*a*) September 17, 1941: Sudden complete fadeout 1400^h–1425^h I.S.T.

(*b*) September 18, 1941: Sudden fadeout (partial) 0750^h–0819^h I.S.T.

(*c*) September 20, 1941: Sudden fadeout (partial) 0800^h–0850^h I.S.T.

(*d*) September 19, 1941: Magnetic storm effect—practically the whole day and night and up to 10 a.m. I.S.T. on the morning of 20th September 1941.

The times given for the commencement of the fadeouts (*a*), (*b*) and (*c*) are those noted at the Receiving Centre at Todapur and differ by a few minutes from those mentioned by the other A.I.R. Receiving Centres, which is mainly due to the sudden and unexpected nature of the phenomenon. The timings given for the end of the fadeouts are very approximate because of the varying duration of the fadeout on different frequencies.

The first three fadeouts can be easily identified as of the Dellinger type on account of the following characteristics:—

(i) The fadeouts occurred during daylight hours.

(ii) The commencement of the fadeouts was very sudden.

(iii) When conditions were returning to normal, stations working in the 16, and 19 metre bands were received before those working in the 25 and 31 metre bands.

(iv) Medium wave stations were not affected.

In addition to the above-mentioned fadeouts there was a severe ionospheric disturbance due to a magnetic storm of great intensity which occurred on September 18th and 19th.[1] The following particulars have been very kindly supplied by the Director of the Colaba Observatory, Bombay:—

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[1] M. R. Rangaswami and A. S. Chaubal, *Curr. Sci.*, 1941, **10**, 432.

"Storm began at 9^h 44^m I.S.T. on 18th September 1941. Became intense between 10^h 20^m to 20^h 22^m on 18th September 1941.

Ended at 17^h I.S.T. on the 19th September 1941."

During the storm, it appears that there were brilliant displays of aurora in the northern and southern latitudes. Reports from the various A.I.R. Receiving Centres indicate that on the 18th September, excepting for a short Dellinger fadeout experienced in the morning, reception conditions were more or less normal, though a few Centres report that there was a tendency for flutter fading and weakening of signals. The worst day so far as radio reception is concerned was the 19th September 1941. The reception of European stations working on the 16, 19, 25 and 31 metre bands was very badly affected. Eastern stations were not markedly disturbed. The F_2 layer critical frequency decreases during a magnetic storm and as is to be expected the 31 metre band was less affected than the higher frequency bands such as 16 metres and 19 metres. It is interesting to note that at a time when no trace of the B.B.C. transmissions was to be had at Todapur, Bombay and Singapore seemed to be getting fairly good reception.

In the case of the Indian regional short wave stations operating in the 41 and 60 metre bands, the signal strength at places within the service area was not affected during the day or the night on the 18th September. But on the 19th September the signal strength of Delhi operating on 41 and 60 metres was found to be much below normal at Lahore and Lucknow, Calcutta on 41 and 60 metres was moderately reduced at Dacca, while Madras on 41 and 60 metres was normal at Trichinopoly. This interesting observation may mean either (1) that the effect of the magnetic storm in affecting the F layer critical frequency was not marked at the low latitudes of Trichinopoly and Madras, or (2) that, though the magnetic storm might have had its normal effect, the lowered value of the critical frequency might have been still high enough so as not to disturb the regional service from Madras.

Pulse observations made at the Receiving Centre at Delhi on a frequency of 7·2 Mc./s. on the afternoon of September 17th, showed normal returns from a layer height of 250 km. just before the disturbance but the returns completely disappeared during the fadeout period, no returns being observed even on 4·8 Mc./s. Just after 1425^h I.S.T., however, returns again appeared from a layer height of 250 km., showing thereby that during this period the F_2 layer ionization and height were not notably affected and that the disappearance of returns was entirely due to the increased absorption in the newly formed ionized layer below the E-region. During the partial fadeout on the morning of September 18th, returns were present but were extremely weak and the layer height did not alter appreciably.

Pulse observations were made on 7·2 Mc./s. from 0700^h to 2300^h I.S.T. on the 18th, 19th and 20th of September 1941. Reflections from layers at normal heights were obtained throughout the period of observation on September 18th, though the reflections were very weak for a brief period in the morning due to the Dellinger fadeout mentioned above. On September 19th however, there were no returns from 0700^h to 2300^h either on 7·2 Mc./s. or on 4·8 Mc./s. Conditions seemed to have improved by the early morning on September 20th and to have become fairly normal by 9^h I.S.T. on that day. These observations using the pulse technique correspond well with the observed reception conditions on the two days (September 18th and 19th, 1941).

An interesting observation is that ionospheric conditions were not markedly disturbed on September 19th up to 2300^h I.S.T. But according to the Colaba Observatory report, the magnetic storm had its maximum intensity on September 18th between 10^h 20^m and 20^h 22^m I.S.T., whereas ionospheric conditions were seriously disturbed during the whole of September 19th up to 2300^h I.S.T. (up to which time the observations were made). There appears to be no coincidence between the most intense period of the magnetic storm and the period of greatest disturbance of the ionosphere, at least so far as observations from Indian stations indicate. However, during the magnetic storm of 1st March 1941, there was close correspondence (as observed at Delhi and at other A.I.R. stations) between the two phenomena while radio reception in India was not markedly affected during the most intense period of the very severe magnetic storm of 24th March 1940.

OBITUARY

PROF. ALFRED JOSEPH CLARK, F.R.S.

MEDICAL SCIENCE in general and Physiology and Pharmacology in particular have suffered a heavy loss by the sudden death of Prof. A. J. Clark, Professor of Pharmacology in the Edinburgh University. He fell ill on the 26th of July 1941, and died on the morning of 30th July at Edinburgh, at the early age of 55.

A distinguished student of King's College, Cambridge, he took his B.A. in 1907 and graduated in medicine in 1910. His assistantship in Pharmacology at the University College, London, easily marked him out as a pharmacologist of exceptional brilliance and the high expectations about him were more than fulfilled when he successively held the chairs of Pharmacology in the University of Cape Town, University College, London, and University of Edinburgh. He succeeded Cushny as Professor of Pharmacology in the Edinburgh University in 1926, and quickly gained the reputation of being one of the most brilliant of British pharmacologists of his day. He became a Fellow of the Royal Society in 1931 and served as an active member of numerous scientific societies. He was on the Editorial Board of the *Journal of Physiology, Quarterly Journal of Experimental Physiology, Journal of Pharmacology* and *Experimental Therapeutics* and several other continental journals of Pharmacology and the pharmacological adviser to the *British Medical Journal.* He saw active service in the last War and was awarded the M.C. and during this war also he was in France and Flanders during the German drive in the last spring. He was a member of the Medical Research Council from 1934 to 1938 and again from 1939 till the time of his death. Serving on the M.R.C. for more than one term is a rare distinction shared by only a few other scientists before.

Besides his scientific publications—many of which were published in the *Journal of Physiology*—Clark gave numerous addresses on scientific subjects and wrote four books which reveal his wide outlook and scientific acumen. His book, "Applied Pharmacology" has passed through several editions during the last 17 years and is equalled in its popularity only by "Applied Physiology" written by Prof. Sampson Wright. The book is a standard book in all English-speaking countries and has found a permanent place on the shelves of students, medical practitioners and research workers. "Action of Drugs on Cells" is a work of outstanding merit and is universally used as a reference book by physiologists and pharmacologists alike, and as Sir Henry Dale has said, 'is likely to have its most permanent effect on the progress of scientific thought and experiment'. "Comparative Physiology of the Heart" was the result of Clark's unequalled experience of the physiology of the heart and his latest contribution "General Pharmacology" written as a supplementary volume to Hefters Pharmacology, is a standard work as a reference book for pharmacology. Besides these books and publications Clark wrote some pamphlets at least one of which has a great significance for medical men and authorities in this country. The pamphlet 'Patent Medicines' in the 'Fact' series gives a vivid description of the problem patent medicines and the art of advertising have created in the modern world. The book has aroused considerable interest and has set medical and administrative authorities thinking seriously about the situation.

Sir Ram Nath Chopra created the modern school of pharmacology in India and it is significant to note that most of Sir Ram Nath's students went to Clark to study pharmacology and obtain wider experience in the subject. Clark had a very soft corner for Indians in his heart and had no racial bias of any kind. Centres of pharmacological research in Madras, Lahore, Calcutta, Patna and Bombay can all testify to the interest Clark took in Indian pharmacology and the enthusiasm he created in the minds of those Indian workers who were fortunate to spend a few years with him. The writer of this note had the good fortune to spend about four years with Clark, first as a student and later as his assistant and remembers numerous occasions on which Clark used to inquire about his past students and their research activities. Sincere, generous and kind hearted, Prof. Clark treated his students and colleagues with the greatest kindness and always tried his best to help them in their difficulties. B.B.D.

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THE HIGH PRESSURE CARBON BAND SYSTEM

JOHNSON AND ASUNDI[1] proved firstly that the so-called high pressure carbon bands formed a system whose final state was the same as that of Swan system and secondly that the emitter of the bands was the C_2 molecule. It has been suggested subsequently by Fox and Herzberg[2] that the bands do not form a new system but are part of the Swan system. The basis for the latter suggestion is not definitely certain; they seem to form a v'' progression involving only another excited vibrational level $v' = 6$, of that system. The following, amongst others, however, shows that this suggestion is not tenable.

In the course of an investigation on the spectra of gases excited by high frequency discharge we have observed that under certain conditions of discharge in a tube from which carbon is not excluded, only the high pressure carbon bands mentioned above are present with low intensity to the exclusion not only of all other bands of C_2 but also of the Swan bands. The following bands are registered on our plates taken on a glass constant deviation spectrograph, the figures in brackets indicating photographic intensities visually estimated:—

λλ 4368·8, 4680·2 5434·9, 5899·3, 6442·3 in A.U.

Int. (1) (2) (0) (2) (1)

If these bands really formed part of the Swan system we get the remarkable result, that high frequency discharge brings about a selective development of only a part of a system of bands. It has been observed by previous workers that certain entire system of bands may be suppressed by h.f. or different conditions of discharge and we have also observed such a selective action in some recent experiments[3] in the case of the band systems of the CO molecule. We, however, do not think that the selective development of only a single

excited vibrational level of a molecule can be brought about this way.

R. K. ASUNDI.
DEVI DATT PANT.

Benares Hindu University,
November 1, 1941.

[1] R. C. Johnson and R. K. Asundi, *Proc. Roy. Soc.*, 1929, **124A**, 668.

[2] J. G. Fox and G. Herzberg, *Phys. Rev.*, 1937, **52**, 638; G. Herzberg, *Astro. J.*, 1939, **89**, 291.

[3] R. K. Asundi, Nand Lal Singh and Devi Datt Pant, *Proc. Ind. Sci. Cong. Asson.*, 1942, Baroda (in the Press).

THE ULTRA-VIOLET BAND SPECTRUM OF MERCURY IODIDE

IN continuation of the work[1] on HgCl and HgBr bands in the ultra-violet the bands of the HgI molecule have also been investigated in the same region. The Class I system reported by Wieland[2] is found to consist of two systems, designated as α_1 and β_1 having a common final level probably a $^2\Sigma$ state. The interval between the upper states is found to be 766 cm.$^{-1}$ approximately.

A new system designated as Class A is obtained in the region λ2540 and is also assigned to the diatomic molecule HgI. It is considered as arising from an electronic transition $^2\Pi - {}^2\Sigma$ showing four component heads, P_1, Q_1, P_2, Q_2 resembling in its structure the Class II system of HgCl.[1] The electronic separation is 126 cm.$^{-1}$. The following vibrational constants for the three systems have been calculated.

	α_1 system	β_1 system	A system
ω_e'	47·7	44·2	98·1 cm.$^{-1}$
ω_e''	55·5	55·5	92·7 ,,
$x_e'\omega_e'$	·8	·4	2·4 ,,
$x_e''\omega_e''$	·8	·8	2·0 ,,
ν_e	38786·7	38022·1	39231·1 ,,
ν_{atom}	4·75	4·72	4·85 volts

Details of the structure will be published elsewhere.

M. G. SASTRY.

Andhra University,
Waltair,
November 20, 1941.

[1] *Curr. Sci.*, 1941, **10**, 169, 197; and *Proc. Nat. Inst. Sci., Ind.* (in press).

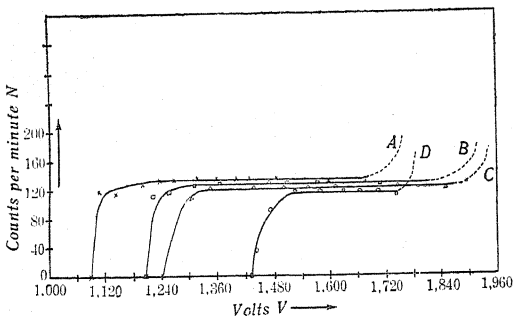
[2] *Helv. Acta Phys.*, 1929, **2**, 46, 77.

HELIUM-FILLED GEIGER-MÜLLER COUNTERS

WE have studied the characteristics of G.M. counters filled with helium in admixture with various alcohol vapours at different partial pressures. The counter was made from pyrex glass with a copper cylinder (2·3 cm. diameter and 12·6 cm. length) inside and a nickel wire (0·1 mm. diameter) running along its axis. After assemblage the surface of the copper cylinder was treated successively with 6 normal and 0·1 normal nitric acid, washed with distilled water ten times and then dried. It was further heated with dry nitric oxide gas inside till the copper surface turned to a dark velvety colour. The helium used had been purified by means of activated charcoal at liquid air temperature. Vapours from ethyl, methyl, normal butyl, isopropyl and laboratory amyl alcohols have been used.

For each of the various organic vapours studied in admixture with helium a total pressure of 10 cm. in the counter was maintained while the concentration of the organic vapour was increased from a partial pressure of 0·5 cm. to 3·5 cm. in steps of half-a-centimetre. The liquid alcohol was kept surrounded by a freezing mixture to keep the amount of water vapour inside the G.M. counter as small as possible, in any case negligible as compared to the alcohol vapour inside. Starting with a 0·5 cm. admixture of alcohol vapour in a total pressure of 10 cm. it was found that the length of the plateau first increased with increasing proportions of the alcohol vapour, but

as the vapour pressure was increased beyond 3 cm. the plateau no longer remained horizontal but became an ascending one. We get the best plateau for the case of helium-methyl alcohol mixture (7 cm. + 3 cm.), for which the plateau extends over 400 volts. Helium-ethyl alcohol mixture also gives an equally good plateau, though the threshold potential is higher in this case. We give the characteristic curves showing the relation between N, the number of counts per minute and V, the potential applied on the wire of the counter for admixtures of ethyl, methyl, isopropyl alcohols and ethyl ether at the same partial pressure of 3 cm. This comparative graph shows that helium-methyl alcohol, and helium-ethyl alcohol are best suited for G.M. counter fillings.



A = Methyl Alcohol.
B = Ethyl Alcohol.
C = Isopropyl Alcohol.
D = Ethyl Alcohol.

It is also noticed that the threshold potential increases with increasing concentration of the organic vapour, which fact is also evident from the work of Trost.[1] We suggest that this increase in the threshold potential is due to the fact that the greater amounts of the organic vapour inside the counter decrease the effective mean free path for the ions by increasing their size considerably (both by condensation and formation of clusters) and thus necessitate larger fields to be applied to produce ionization by collision and initiate a discharge. Comparison with Trost's observations on argon-alcohol counters shows that for helium-alcohol counters the threshold potentials are consistently lower than for counters that are filled with argon and alcohol.

Details will be published elsewhere.

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H. R. SARNA.
CHARANJIT.

Physics Laboratory,
Government College, Lahore,
October 31, 1941.

[1] Trost, *Zeit. für Physik*, 1937, **105**, 399.

4-CO-ORDINATED MERCURIC SALTS WITH DIAMINES AND A NEW METHOD OF ESTIMATING MERCURY

IT is generally held that among the salts of mercury, only those of oxyacids are able, under suitable conditions, to form tetramine compounds. Substitution and hydrolysis, however, occur even in these cases. The incapacity of mercuric halides to combine with more than two molecular proportions of amines is attributed to their low degree of ionisation. Von E. Schering[1] has described bis-ethylene diamine mercuric chloride which is a four co-ordinated mercuric halide. The present author finds that such a compound does not exist in a pure form in the solid state. Both mercuric chloride and mercuric bromide are found to form with equimolecular proportions of ethylene diamine, white mono compounds which are insoluble in water. Though these dissolve in excess of the diamine and give water-soluble products, pure bis-ethylene diamine mercuric halides cannot by any means, be obtained from them. They are completely converted into insoluble mono compounds in the process of washing with alcohol or crystallisation from water. It has, however, been possible to prepare bis-ethylene diamine mercuric chloroplatinate in addition to bis-ethylene diamine mercuric salts of oxy-acids. The chloroplatinate is insoluble in water and does not change when kept in a desiccator over sulphuric acid for a long time. In fact, the stability of the compound is such that it becomes possible to estimate mercury accurately by a simple method. To alcoholic

solutions of mercuric salts, ethylene diamine is added in just sufficient quantity to dissolve the precipitate first formed. Aqueous ammonium chloroplatinate is then added to the solution obtained till the light yellow precipitate of the chloroplatinate ceases to be formed. The precipitate is washed thoroughly at first with water, then with alcohol and after drying in a desiccator over sulphuric acid, weighed as $Hg\ en_2\ Pt\ Cl_6$. It appears that mercury can also be estimated as bis-ethylene diamine chloroplatinite. Propylene diamine, it may be noted, can be used instead of ethylene diamine in all the reactions described above.

KANAI LAL MANDAL.

Chemical Laboratory,
Presidency College,
Calcutta,
September 15, 1941.

[1] Von E. Schering, *Chemische Fabrik, Auf Actien—D. R. P.*, 12095.

APPLICATION OF FRIES REACTION TO ESTERS OF HYDROQUINONE

FRIES reaction[1] has been successfully applied to esters of resorcinol and catechol. Numerous heterocyclic compounds (*e.g.*, coumarins, chromones, furo-coumarins, flavones, etc.) have been prepared from resacetophenone obtained from resorcinol. No work seems to have been done on corresponding derivatives of hydroquinone. However, oxygen containing heterocyclic compounds such as chromanes, coumarans and dihydrocoumarins have been prepared in large numbers, on account of their expected vitamin E activity, by the action of allyl halides or hydroxides on hydroquinone and its derivatives.[2]

In order to prepare the various oxygen containing heterocyclic compounds corresponding to hydroquinone, it was necessary to obtain the different ortho hydroxy ketones of hydroquinone. The simplest member, *viz.*, 2 :5-dihydroxy acetophenone was found recorded in literature and was prepared by Nencki's reaction,[3] from hydroquinone, acetic acid and fused zinc chloride. The yield of the ketone was, however, very poor. Regarding the other method of obtaining the ketone, *viz.*, the Fries reaction, two workers have independently recorded negative results in the case of hydroquinone diacetate.[4]

On looking up the original paper of Heller[4] it was found that he had used ferric chloride in place of the more usual anhydrous aluminium chloride. This may, perhaps, have been the cause of his negative observation. Mauthner[4] used anhydrous aluminium chloride and still failed to observe the Fries reaction.

Although the usual experimental conditions recommended by Rosenmund and Schnurr,[5] for the Fries transformation, generally give satisfactory results in most of the cases it is my experience that in some cases, higher temperature, larger proportion of aluminium chloride and longer period for the reaction are necessary to bring about the Fries reaction. It was, therefore, thought worthwhile to try Fries reaction on esters of hydroquinone under modified conditions. The results have been successful, and satisfactory yields have been obtained in the case of hydroquinone diacetate and hydroquinone dibenzoate.

On heating hydroquinone diacetate m.p. 121° with anhydrous aluminium chloride a substance m.p. 202° was obtained in 76 per cent. yield. The substance m.p. 202° was identified as 2 :5-dihydroxy acetophenone by direct comparison with a sample of the same prepared by Nencki's method (*loc. cit.*).

In the same way, hydroquinone dibenzoate m.p. 204°, on heating with anhydrous aluminium chloride, gave a substance m.p. 125° in 42 per cent. yield. The substance m.p. 125° was identified as 2 :5-dihydroxy benzophenone by direct comparison with a sample of the same prepared according to the method of Bogert and Howells.[6]

All attempts to prepare the 2 :5-dihydroxy benzophenone by Nencki's method failed. It is

interesting to note that by heating benzoic acid and hydroquinone in the presence of fused zinc chloride, mono- and dibenzoate of hydroquinone are obtained instead of the above mentioned ketone.

The work of extension of Fries reaction to other esters of hydroquinone and its derivatives, and of the use of the resulting ketones in the preparation of different heterocyclic compounds is in progress.

R. Y. SHAHANE.

Chemistry Department,
Sir Parshurambhau College, Poona 2,
October 8, 1941.

[1] Fries and Finck, *Ber.*, 1908, **41**, 4271.
[2] Smith, *Chemical Reviews*, October 1940.
[3] Nencki and Schmid, *J. Prac. Chem.*, (2), **23**, 546.
[4] Heller, *Ber.*, 1912, **45**, 2389; Mauthner, *J. Prac. Chem.*, (2), **149**, 324–27.
[5] Rosenmund and Schnurr, *Ann.*, 1927, **460**, 56.
[6] Bogert, and Howells, *J. A. C. S.*, 1930, **52**, 842.

THE FRIES MIGRATION OF THE ESTERS OF POLYHYDROXY PHENOLS

ORTHO as well as para hydroxy Ketones are important intermediates for the synthesis of a number of heterocyclic compounds and oxy-azo dyes. Therefore, any method that enables us to prepare them smoothly and conveniently is particularly welcome. A study of the application of the Friedel-Crafts and the Nencki Reactions by the author and his co-workers[1] has shown that it is not always possible to get the requisite hydroxy-ketones in good amounts by these methods. Therefore, we have now studied the Fries migration of the acetates and benzoates of orcinol, hydroquinone, pyrogallol and phloroglucinol, etc., under varying conditions of time, temperature and the amount of the catalyst ($alcl_3$). Some of the interesting results are summarised hereunder:

(1) Hydroquinone diacetate as well as dibenzoate gave good yields of 2:5-dihydroxy aceto-phenone and 2:5-dihydroxybenzophenone. This is thus the best method of preparing these compounds.

(2) Orcinol diacetate gave 2:4-diacetyl-orcinol which can be readily deacetylated to γ-orcacetophenone. This method of preparing γ-orcacetophenone is superior to that of Desai and Vakil (*loc. cit.*).

(3) Pyrogallol triacetate gave exclusively gallacetophenone (excellent yield).

(4) Phloroglucinol triacetate gave mainly 2:4:6-triacetyl, or 2:4-diacetyl phloroglucinol according to conditions, and phloracetophenone only in traces. The work is being extended to other esters.

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C. K. MAVANI.

The Chemistry Department,
St. Xavier's College,
Bombay 1,
November 20, 1941.

[1] Desai and co-workers, *Proc. Ind. Acad. Sci.*, 1938, **8A**, 194; 1940, **11**, 140, 149; **12**, 46, 392, 507; **13**, 33, 40, 132.
[2] Fries and Finck, *Ber.*, 1908, **41**, 4271.

THE APPLICATION OF THE NENCKI REACTION TO β-NAPHTHOL

BY the application of the Nencki Reaction to α-naphthol using lauric, palmitic and stearic acids, the authors[1] have got good yields of 2-lauryl-, 2-palmityl-, and 2-stearyl-1-naphthols. The same reaction does not take place smoothly with β-naphthol using lower fatty acids like acetic and propionic acids. Thus 1-acetyl-2-naphthol is not obtained in good yield on heating β-naphthol with acetic acid in presence of anhydrous zinc chloride, and the best method of preparing this hydroxy-ketone is the Fries migration[2] of β-naphthyl-acetate. We have now studied the Nencki reaction between β-naphthol and lauric, palmitic and stearic acids, and find that excellent yields of 1-lauryl-, 1-palmityl- and 1-stearyl-2-naphthols are obtained. The various chemical properties of these interesting hydroxy-ketones have been studied with a view to instituting a comparison

with their analogues. Fuller details will be published elsewhere in course of time.

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W. S. WARAVDEKAR.

The Chemistry Department,
St. Xavier's College,
Bombay 1,
November 20, 1941.

[1] Desai and Waravdekar, *Proc. Ind. Acad. Sci.*, 1940, **12A**, 507.

[2] Fries, *Ber.*, 1921, **54**, 709.

STUDIES IN INSECT NUTRITION: THE NATURE OF THE FAT-SOLUBLE FACTOR

IN an earlier communication it was pointed out that the rice moth [*Corcyra cephalonica*, Staint (Lep.)] requires a fat-soluble growth-promoting factor, as revealed by Table I.

TABLE I

Diet	Wt. of 10 larvæ in milligrams after a period in days		
	10	20	30
Whole cereal (Jowar) ..	8·6	75·8	170·0
Ether extracted Jowar + refined groundnut oil	1·6	3·5	5·0
Do. + Ether extract	6·8	67·3	145·6

With a view to determine the nature of the growth-promoting factor, the ether extract of Jowar, "Jowar Oil", has been investigated. The above figures suggested the probability of the growth-promoting factor being associated with the non-glyceride fraction of the "oil".

50 gm. of the Jowar "Oil" were saponified for 2 hours in an atmosphere of nitrogen. After saponification, the mixture was diluted with an equal amount of water, and the solution extracted six times with batches of 200 c.c. of ether. The ether extract was dried over anhydrous sodium sulphate for 24 hours and the ether distilled off in an atmosphere of nitrogen.

The residue was subjected to a second saponification adopting the above procedure and the non-saponifiable matter extracted with ether. The ethereal solution was assayed for its growth-promoting activity towards the larvæ of the rice moth (see Table II).

TABLE II

Diet	Wt. of 10 larvæ after a period in days		
	16	26	32
Whole Jowar ..	18·5	172·7	290·0
Ether extracted Jowar + refined groundnut oil	2·2	10·4	22·5
Ether extracted Jowar + non-saponifiable matter	8·44	99·0	175·0
Do. + refined groundnut oil	11·0	130·0	222·0

The results in Table II point to the conclusion that the factor gets concentrated in the unsaponifiable fraction of the oil.

The non-saponifiable fraction, which has been shown to contain the factor, was subjected to a further fractionation. Xanthophylls and the resin acids associated with the fraction were eliminated by washing the petrol ether solution of the unsaponifiable fraction with 85 per cent. methyl alcohol; the petrol ether layer retained the sterols and the carotenes. The two fractions were assayed employing the rice moth. The results given in Table III showed that the active factor was associated with the petrol ether layer.

TABLE III

Diet	Wt. of 10 larvæ in milligrams after a period in days		
	14	26	30
Whole Jowar .	14·4	177·0	250·0
Ether extracted Jowar + petrol ether fraction	12·6	170·0	248·0
Do. + alcohol fraction	1·8	7·7	10·7

The petrol ether fraction was further purified and the sterols crystallised, which on assaying, was found to possess the growth-promoting factor. The sterol crystals have an m.p. 75°–76° C. and a specific rotation of —17·76° (25° C. chloroform solution). Attempts at a further purification and identification of the factor are now in progress.

P. S. SARMA.
M. SREENIVASAYA.

Indian Institute of Science,
Bangalore,
December 9, 1941.

A RAPID CHROMIC-NESSLERIZATION METHOD FOR THE ESTIMATION OF NITROGEN IN BIOLOGICAL MATERIALS

THE applicability of the chromic oxidation method for the estimation of nitrogen in pure organic compounds as well as in natural plant and animal products, has been examined in detail by one of us[1] and it was shown that if suitable precautions be adopted, the method gives fairly satisfactory results in the case of soils, plant materials and composts. Since the method is simple and avoids the need for a special fume-cupboard characteristic of kjeldahl digestions, an attempt was made to further simplify the technique by omitting the subsequent distillation procedure for ammonia, so that even the supply of flowing water and of gas could be dispensed with, and it may become possible to carry out the nitrogen determinations even in places where such gas and water facilities may not be available. The aim was primarily to enable educated farmers, municipalities and village panchayats to determine the nitrogen content of their soils, composts and organic manures with simple equipment not involving the supply of gas and flowing water.

We have found that it is possible to devise a method satisfying the above conditions and giving results agreeing with the Kjeldahl values, by proceeding as follows:—0·2 to 0·5 gm. of the material taken in a test-tube is oxidized with 5 c.c. of chromic-sulphuric mixture for 5 minutes at 200° C. in a castor oil bath (heated by a wick-stove), after which the contents are diluted and the excess of chromic acid and traces of nitrate present are reduced by addition of sodium sulphite. The chromium is then precipitated by the addition of sodium carbonate to slight alkalinity, the contents are made up to a known volume and an aliquot filtered off for the estimation of ammonia by nesslerization.

About a dozen samples can be kept for oxidation simultaneously in test-tubes in the oil-bath and by use of tinted glasses showing ranges of nessler-colours, it is possible to carry out the above one dozen estimations in about 2 hours time.

Full details of the experimental procedure and results obtained would be published elsewhere.

C. N. ACHARYA.
K. S. KRISHNA RAO.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
November 14, 1941.

[1] *Biochem. J.*, 1936, **30**, 241, 1026; *Nature*, 1935, **136**, 644; *cf* also *Proc. Ind. Acad. Sci.*, 1934. **1B**, 155; 1935, **28**, 213; *J. Soc. Chem. Ind.*, 1935, **54**, 34T; *J. Ind. Inst. Sci.*, 1936, **19A**, 45; *Curr. Sci.*, 1941, **10**, 261.

A NOTE ON THE "LEAD-RATIO" METHOD FOR DETERMINING THE AGE OF THE DECCAN TRAPS

THE various methods that have been applied hitherto for the determination of the geological age of the Deccan Traps in India by different workers, are known to be based mostly on the stratigraphic as well as palæontological evidences derived from the fossil remains of the sedimentary beds (inter-trappean and infra-trappean) found in association with these traps. From the palæontological evidence the Tertiary age has been assigned to the Deccan traps.[1,2,3,6] On the other hand, stratigraphical evidences led various workers to attribute

either the late Cretaceous or early Tertiary period to these volcanic formations.[4,5]

A few years back an attempt made by us to determine the age of some specimens of the Deccan Trap (basic lavas) of Bombay and Salsette Islands by the "lead-ratio" method of the actual analyses of rocks for their uranium, thorium and lead contents, gave encouraging results as shown in the following table:—

Specimen and Slide	Name of the rock	Locality	Structure	Alteration	% Uranium	% Thorium	% Lead	Pb / U + 0·36 Th	Calculated age in millions of years	Geological Horizon
1	Andesine Andesite	From the seashore in the vicinity of the Indian Military Quarters opposite the Afghan Church, Colaba (18°–58½′ : 72°–49′)	A little coarse	Almost none	$20{\cdot}988 \times 10^{-2}$	Nil	$13{\cdot}531 \times 10^{-4}$	0·006	45·6	Oligocene
2	Andesine Andesite	From a small exposure, near Altamount Road, Cumballa Hill (18°-58½′ : 72°–48′)	Very compact	Slight	$21{\cdot}703 \times 10^{-2}$	Nil	$13{\cdot}531 \times 10^{-4}$	0·006	45·6	Oligocene
3	Basalt	Collected from a quarry worked at a distance of some yards to the west of the Goregaon Railway Station, Goregaon (19°–10′ : 72°–51′)	A little coarse	Slight	$11{\cdot}686 \times 10^{-2}$	Nil	$11{\cdot}598 \times 10^{-4}$	0·009	68·4	Lower Eocene
4	Basalt	Exposure in the low grounds of Borivli at a distance of about a mile to the east of the Railway Station, Borivli (19°–14′ : 72°–52′)	Coarse grained	Slight	$11{\cdot}686 \times 10^{-2}$	Nil	$8{\cdot}698 \times 10^{-4}$	0·007	53·2	Upper Eocene

In this table the specimens collected from Bombay and Salsette Islands are found to belong to the Tertiary period and their age results also indicate two distinct lava flows, one of 45·6 million years (Oligocene) and the other of about 60 million years (53·2 to 68·4 million years), *i.e.*, Eocene, corresponding to the two distinct flows of lava as postulated by Dubey[3] who remarks that "both kinds of basalt exist in Bombay, one of the early tertiaries and the other of the late tertiaries".

These indications are decidedly encouraging and justify our attempt in applying the analytical "lead-ratio" method for evaluating the age of the Deccan Traps. A careful scrutiny of the present-day literature shows that the method has not been applied so far to igneous rocks forming the Deccan Traps.

In applying the "lead-ratio" method we have determined the amounts of uranium, thorium and lead in fresh specimens by chemical methods. The percentage error is minimised by using large quantities, as much as 50 gm., in the uranium determinations. Further, the determinations of all the three elements (U, Th, Pb) have been carried out on the same sample. Considering that the amounts used by us in the chemical analyses are much larger than the usual 0·5 gm. or 1 gm. generally taken in an analysis, our data fulfils the high accuracy required for ascertaining the geological age. Errors due to alteration caused by outside agencies have been avoided by selecting the specimens far away from the weathered regions and also by carrying out the relevant microscopic study of the specimens.

From the results of our analyses we have calculated the age of the rocks from the following formula,[7]

$\frac{\%\ Pb}{\%\ U + 0{\cdot}36\%\ Th} \times 7{,}600$ million years,

and have assigned geological epochs to the rock samples under investigation following the time division scale adopted by Barrel[8] and W. D. Urry.[9]

As regards the validity of the "lead-ratio" method as applied by us to these rocks, it is true that no objection can be raised against the method if the atomic weight of "rock-lead" is determined, for that would be conclusive evidence as to its presence by radioactive changes of uranium and thorium. Because of the small amounts of lead, the atomic weight determination by purely chemical methods is out of question. In future perhaps, the improved technique in the mass spectrograph will be able to establish the isotopic nature of "rock-lead" in which case the origin of "rock-lead" will no more be a moot point and the "lead-ratio" method will be safely applied for measuring the geological time. In spite of this limitation, the fact that our chemical results are supported by independent palæontological evidence has convinced us that "rock-lead" obtained during our analyses is of radioactive origin.

Arthur Holmes[10] points out that igneous rocks of volcanic origin contain uranium and thorium and are richer in these elements than the plutonic types. Besides, from the thermal consideration, it appears that the radioactive elements, uranium and thorium, have been systematically concentrated towards the outer part of the lithosphere.[11] Further, Dubey[7] has applied the helium method to the Deccan traps from Pawagarh Hills in Kathiawar which proves the presence of radioactive uranium in the Deccan traps. The presence of uranium is further confirmed by the results of our analyses. Considering the fact that the Deccan traps (basic lavas) are of volcanic origin, and that the specimens collected by us in Bombay and Salsette Islands come from localities where contamination by extraneous lead is not possible, we may be justified in assigning the presence of small amounts of lead found in our specimens as being of radioactive origin.

Further work on these lines from the geological standpoint has been carried out in the Department of Geology, St. Xavier's College, Bombay, and the results will be published when they are ready.

A. S. KALAPESI.
S. K. CHHAPGAR.
R. N. SUKHESWALA.

St. Xavier's College,
Bombay,
October 15, 1941.

[1] Rama Rao, L., Narayan Rau, S. R,, and Sripad Rau, K., *Proc. Ind. Acad. Sci.*, 1936, **3.**

[2] Sahni, B., *Curr. Sci.*, 1934, **2.**

[3] " The age of the Deccan Traps," Section of Geology and Geography. *Abstracts of Discussions, Ind. Sci. Cong. 24th Annual Meeting*, Hyderabad, 1937.

[4] Fox, C. S., *Rec. Geol. Surv. India*, **62,** Pt. 1.

[5] —, *Curr. Sci.*, March, 1935.

[6] Rama Rao, L., *Proc. Ind. Acad. Sci.*, 1936, **4.**

[7] *Bulletin of the National Research Council*, No. 80, June 1931, Physics of the Earth—IV, the Age of the Earth.

[8] Wilmarth, M. Grace, " The Geological Time Classification of the United States Geological Survey compared with other Classifications," *United States Geological Survey Bulletin*, 769.

[9] " Report of the Committee on the Measurement of Geologic Time," Alfred C. Lane, Chairman: Presented at the Annual Meeting of the Division of Geology and Geography, National Research Council, April 27, 1935.

[10] Holmes, A., *Science Progress*, 1914, **9,** 12.

[11] Strutt, R. J., *Proc. Roy. Soc. London*, 1906, **77A,** 472.

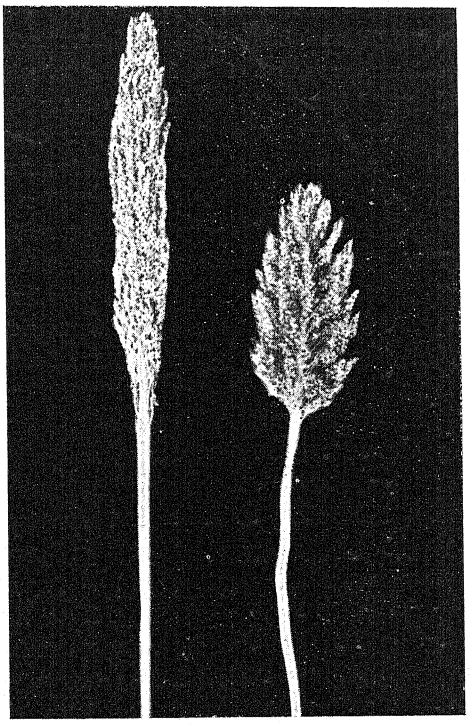
WAVY PEDUNCLE—THE BASIC CAUSE OF GOOSE-NECKING IN SORGHUM

GOOSE-NECKING occurs in some varieties of sorghum. These are mostly Asiatic and belong to the compact headed, short stalked *Durra* sub-series of grain sorghum. This phenomenon occurs in the American variety Milo which belongs to *Sorghum subglabrascens* of the *Durra* sub-series. In examining this character Conner and Karper[1] have observed that the tight inrolling of the top portion of the boot makes the panicle bend out in the place of least resistance giving rise to goose-

necking. Martin[2] records that the causes are thick heads and a narrow boot.

Experiences gained at the Millets Breeding Station, Coimbatore, have helped to throw more light on this phenomenon. It has been noted (1) that big heads that are not goose-necked are common, (2) erect peduncles occur in both big and narrow boots, and (3) with impediments to emergence there have been isolated cases of long peduncles with goose-necking.

In a fodder type of *Sorghum sudanense* received from Odessa in the U.S.S.R. there occurred a type whose peduncles were not straight but very broadly wavy. This type



Straight peduncle Wavy peduncle

was e-ligulate and had therefore a compact panicle.[3] In a few cases where the emergence of the tiller head was poor there occurred goose-necking. This suggested a possible connection between the attribute of waviness of peduncles and the manifestation of goose-necking. An examination of the wide sorghum collections showed that the waviness (which may vary from noticeable undulations to a very shallow disturbance which can be easily felt when the stalk is passed between fingers) occurs in some of the types of cultivated sorghum (photograph).

In pure lines it was noticed that in wild sorghums with the exception of the above mentioned *S. sudanense* type only the *Para sorghums* tended to have wavy peduncles.[4] In cultivated sorghums this character was common in the types belonging to the *Durra* sub-series. Waviness could exist both in long and short peduncles. When the peduncle is long (emergence is good) the wavy factor does not produce goose-necks unless there is an impediment in the emergence of the earhead. When the emergence is poor (peduncles shorter than the boot), the panicle being heavy and the wavy factor present, goose-necking occurs. The earhead takes a twist and dodges the boot. In such earheads, the wavy nature is easily discernible in the lower half.

Many earheads of *Bajri* (*Pennisetum typhoides*) have wavy peduncles and occasionally goose-necking occurs when there is an impediment to free emergence.

Wavy peduncled types have been true to waviness through generations. In a cross between a wavy peduncle and a straight peduncled *S. sudanense* type, the first generation plants had straight peduncles and in subsequent F_2 and F_3 generation a monohybrid segregation was obtained and confirmed.

In cultivated sorghums a cross was made between a straight peduncled type (A.S. 5157) and a wavy peduncled one (A.S. 3783). The F_1 had straight peduncles. The F_2 generation segregated and gave 163 plants with straight peduncles and 55 plants with wavy ones.

It will thus be noticed that a gene designated w_y is responsible for wavy peduncles. Gene W_y produced the common straight peduncle. Waviness occurs both in long and short peduncles. When the peduncles are shorter than the sheath, the wavy factor helps the heavy earhead to bend and this results in goose-necking. In badly emerged heavy heads without the

help of the wavy factor a part of the panicle remains stuck up within the boot with consequent unsetting in the portion enclosed.

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Millets Breeding Station,
Coimbatore,
November 11, 1941,

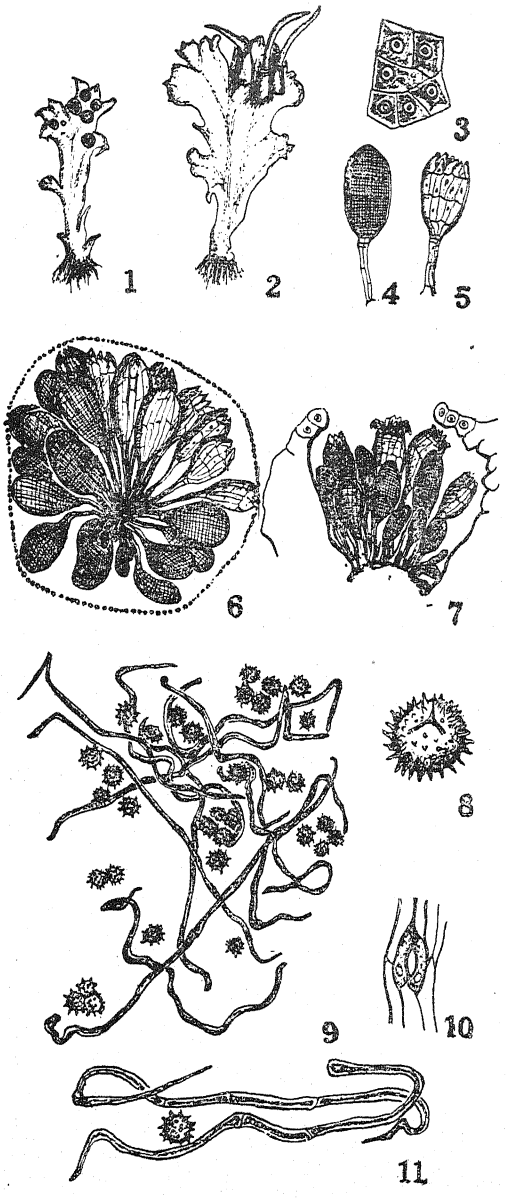
1 *Texas Agri. Expt. Station Bull.*, 1917, No. 204.
2 *Jour. Amer. Soc. Agron.*, 1932, **24**, 500–03.
3 *Proc. Indian Acad. Sci.*, 1938, 7, 286–88.
4 *Ibid.*, 1941, **14**, 17–24.

A LONG-LOST LIVERWORT FROM SOUTH INDIA: *ASPIROMITUS*, A RARE MEMBER OF THE ANTHOCEROTES

IN July 1932, on a collecting trip to Khandala (Bombay Presidency), a form of the Anthocerotes was collected which appeared to be peculiar in many respects. The collection consisted of a large number of male thalli with peculiar antheridia but the female thalli were wanting altogether in the collection; and hence no identification of the plant was possible. A somewhat similar form[1] was also noticed to grow at Castle Rock in 1935. Year after year the plant was being collected without getting any further clues as to its identity till the year before last, when I had the privilege of working in the laboratory of Prof. Birbal Sahni at Lucknow, I handed over a few specimens of this plant to Dr. S. K. Pande who drew my attention to the fact that the antheridia in these specimens suggest it to be a species of *Aspiromitus*.[2] The definite identification of the plant, however, was not possible in the absence of any mature sporogonia.

Early in the last October and in June this year, a rigorous search for the plant was made by me at several places, and collections were made from time to time at my request by Mr. P. D. Bhate and others at Khandala from the same localities from where I used to collect the material, and subsequently at Castle Rock by Prof. D. V. Shende, and were sent to me.[3] These included female thalli with mature sporophytes and it became possible to make out the broad features in the morphology of this plant which are given below.

Description of the Plant.—Plants dicœcious, large, terrestrial, growing in close clusters, light green in colour. Fronds cavernous, more or less erect, attached to the soil by a tuft of rhizoids, smooth or tuberculate (Figs. 1 and 2). Male thalli 1–1·7 cm. long, about 6 mm. broad, erect, cuneate, furcately lobed; lobes irregular, unequal, crenulate or ligulate, with a distinct network of mucilage canals or the so-called nerves (Fig. 1). Andrœcia in clusters, in two or three series, lying a little below the recurved margin of the thallus in the notches or depressions of the lobes. Antheridial cavities large, round, containing about 20–24 antheridia in each cavity (Figs. 6 and 7). Antheridia 34 μ long, 15–20 μ broad, with stalks about 24 μ long (Figs. 4 and 5), elliptical or ovate-elliptical in outline, subglobose or club-shaped (Figs. 4–7), seated on the central portion of the chamber from which they appear to radiate like the antheridia in a male conceptacle of *Fucus* (Figs. 6 and 7). Female thalli large, 2–3 cm. long, as much broad, sometimes more, subplane, growing in clusters, semi-erect, spreading in a fan-like manner, thick and fleshy, light green or yellowish green in colour, longish, furcately lobed, lobes round or ligulate, margin repand or slightly incisioned, revolute (Fig. 2). Involucres large, about 4 mm. long, fleshy, cylindrical, smooth, solitary or rarely two on a lobe, subacuminate (Fig. 2). Capsule 1·5–2 cm. long, stout, dark green, with a long foot and a columella running right up to the apex. Dehiscence of the capsule by two valves splitting it open along two vertical lines into two segments not twisting each other. Epidermal cells of the capsule elongated, and heavily cuticularised. Stomata many, about 25 μ long, 16–20 μ broad (Fig. 10). Spores dark, black when thoroughly matured, about 40 μ in diameter, echinate, mixed up with and enfolded by numerous dark, long elaters (Figs. 8 and 9). Elaters 100–160 μ long, solid, smooth, simple, septate, unbranched, pointed or blunt at ends, with inner surface cuticularised but having neither spiral nor any other kind of



FIGS. 1—11. *Aspiromitus Dixitianus* Mahabalé, n.sp. FIG. 1—Male thallus. × 1·5; FIG. 2—Female thallus. × 1; FIG. 3—A portion of the thallus showing a large single chloroplast in each cell. × 62·5; FIG. 4—Mature antheridium. × 22·5; FIG. 5—An empty antheridium. × 22·5; FIG. 6—Optical view of an antheridial cavity containing about 24 antheridia in different stages of development. × 12·5; FIG. 7—*Ibid.*, vertical section. × 12·5; FIG. 8—Spore. × 175 approx.; FIG. 9—A group of spores and elaters in the capsule. × 75; FIG. 10—Stoma on the wall of the sporogonium. × 75; FIG. 11—Two elaters magnified. × 100.

thickening, dark, deep purple or black in colour (Figs. 9 and 11).

Habitat—Moist overhanging rocks on the westward side of the ghats in the Bombay Presidency, above 2,300 feet elevation.

Locality—Hills behind the Reversing[4] Railway Station (G.I.P. Ry.), Bor Ghat, Khandala: Battery Point,[5] Khandala: Railway Bridge[6] over the Bombay-Poona Road, near Reversing Station (G.I.P.).

Systematic Position.—The plant undoubtedly belongs to the group of Anthocerotes as is evident from the fact that there is a single large chloroplast in each cell of the thallus (Fig. 3). The Anthocerotes comprise five genera: *Anthoceros*, *Aspiromitus*, *Megaceros*, *Dendroceros* and *Notothylas*. The stomata are absent on the walls of the sporogonia in *Megaceros*, *Dendroceros* and *Notothylas*, and therefore, the plant in question belongs either to the genus *Anthoceros* or to the genus *Aspiromitus*. This inference is further confirmed by the fact that the elaters in *Megaceros*, *Dendroceros* and *Notothylas* have spiral markings which are wanting in the elaters of *Anthoceros* and *Aspiromitus*.

The genus *Aspiromitus* differs from the genus *Anthoceros*, among other characters, in two important respects: (1) the form and number of antheridia in an antheridial cavity, and (2) the form, length, colour and thickening of the pseudo-elators. In the majority of the species of *Anthoceros* the antheridia are globose or oval, and 3–4 of them lie in an antheridial cavity, rarely 8. The antheridia of *Aspiromitus* are sub-globose, more or less club-shaped, oval-elliptical in outline and raised on long stalks. As a rule many of them are found in each cavity; or, if they are few, their size is considerably larger than that of those of *Anthoceros*. In the present plant about 20–24 of them lie in an antheridial cavity or the chamber. The other important character of the genus *Aspiromitus*, and from which it derives its name, is the nature of its elaters. They are smooth, solid, long, thread-like, usually coloured, the colour being the same as that of the spores. Unlike the elaters in the most

species of *Anthoceros* they are generally unbranched and have no spiral markings. At maturity they lie scattered in the masses of spores, especially in the upper part of the capsule; and in the earlier stages they encircle the tetrad-spores. Their length, like their colour, is quite considerable. It is 10–20 times greater than that of the elaters in the species of *Anthoceros.* For example, the length of the pseudo-elaters in *Anthoceros erectus,* with which the plant is often mixed up, is 12 μ whereas in the form under consideration it is about 100–160 μ, nearly 8–13 times greater than that of the elaters of the former plant.

From what has been said above, it is evident that the plant under consideration belongs to the genus *Aspiromitus.*

Historical.—The genus *Aspiromitus* was founded by Stephani in 1888 and is the least known member of the Anthocerotaceæ. Stephani[7] has described 53 species of this genus in his '*Species Hepaticarum*', mostly from Africa, tropical America, Java, Sumatra, and Australia. These include, *inter alia,* a species from South India named *Aspiromitus mangaloreus* St.[8] named by him after the place from where the specimens were obtained, namely from Mangalore[9] in the District of South Canara in the Madras Presidency. To the best of my knowledge this perhaps is the only record of the occurrence of this genus in India. But the plant under consideration does not seem to belong to that species, as *A. mangaloreus* St. is a monœcious form with hispidate spores, 27 μ in diameter. The present species is diœcious and has echinate spores about 40 μ in diameter. It is, therefore, not *A. mangaloreus* St.

A species novum.—It may next be enquired whether the plant under consideration belongs to any other species of this genus described by Stephani. Out of the 53 species of *Aspiromitus* described by him the following 4 species are diœcious: *A. incurvus* St., and *A. expansus* St. from Kamerun in Africa, *A. rigidus* St. from Jamaica, and *A. dioicus* St. from Amazonas in tropical America. In *A. incurvus* St. and in *A. rigidus* St. the spores are pale in colour, and in the other two species they are dark in colour. The plant in question has dark spores and it is, therefore, allied to *A. expansus* St. from Kamerun and to *A. dioicus* St. from tropical America. In *A. expansus* St., however, the spores are hispidate and about 36 μ, as against the echinate spores 40 μ in diameter in the present species. The capsules also of *A. expansus* St. are longer than those of the species under consideration: in the former plant they are 3 cm. long and in the latter they are 1·5–2 cm. long. In *A. dioicus* St. the spores are asperate and 36 μ in diameter. It also, therefore, does not seem to correspond to the form in question. But the real distinguishing feature of this species from the plant under consideration is its antheridia. The antheridia of *A. dioicus* St. are described by Stephani[10] as "*gigantea*" and 3–5 of them lie in an antheridial cavity. The antheridia of the present form are certainly not gigantic and 20–24 of them lie in each cavity. The plant under consideration, therefore, does not seem to belong to that species also. From *A. expansus* St. it differs in the size and markings of the spores and in the length of the capsules; and it differs from *A. dioicus* St. in the size and markings of the spores, and in the size and number of antheridia in each antheridial cavity. And as it does not tally with any of the species of this genus described so far, it is to be considered new. I have called it *Aspiromitus Dixitianus* sp. n. giving it a trivial specific name "*Dixitianus*" in acknowledgment of my debt to my teacher in Cryptogamic Botany, Prof. D. L. Dixit of the Fergusson College, Poona.

The type specimens are deposited in the Department of Biology, Gujarat College, Ahmedabad (Western India) and the Latin diagnosis of the species is given below.

Aspiromitus Dixitianus Mahabalé, n. sp.—*Planta* dioica, majuscula, cavernosa, erecta vel semi-erecta, terricola, flavo-virens, plus minusve cueniformis. *Frons feminina* 2–3 cm. longa, 2·5 cm. lata, dilute viridis, grosse cavernosa, robusta, subplana, longe furcata, ramis lobulata, lobis rotundis, vel ligulatis; marginibus repandis, revolutis. *Frons masculina* parva, 0·5–1·7 cm. longa, 6 mm. lata, cueniformis, irregulariter

furcata, margine inciso-lobulatis, lobis crenulatis, et ligulatis et inequilatis. *Involucra* 4 mm. longa, cylindrica, cavernosa, subacuminata, solitaria, rarius gemminata. *Capsula* 1·5–2 cm. longa, valida. *Stomata* numerosa. *Sporae* 40 μ, fuscae, generatim in statu maturo nigrae, echinatae. *Elateres* fusci, longi, simplices, septati, ejusden coloris, reticulis 4 sporas includentibus. *Andrœcia* aggregata, alveolis magnis, rotundis. *Antheridia* 34 μ longa, longis pedicellatis erecta, elliptico-ovalia, ad 20–24 in utroque alveolo.

Hab.—*India occidentalis,* Khandala, Bombay Presidency.

T. S. MAHABALE.

Department of Biology,
Gujarat College, Ahmedabad,
October 27, 1941.

[1] This form differs in some important points from the form found at Khandala and I hope to give its account in some later communication.

[2] Dr. S. K. Pande's letter to me dated 29th October 1940. I take this opportunity to thank most sincerely Dr. Pande for the brilliant suggestion, and to Dr. H. Chaudhuri, Director, Kashyap Research Laboratory, Lahore, for the loan of some books.

[3] My best thanks are due to these gentlemen and to Messrs. R. N. Deshpande, S. R. Deshpande, and Y. B. Raje for the help they rendered in getting me the proper material.

[4] Mr. R. N. Deshpande's collection, 1932.

[5] The author's collection, 1932.

[6] Coll. P. D. Bhate, 1940; Y. B. Raje, 1932, 1941; S. R. Deshpande, 1941.

[7] Stephani, F., *Species Hepaticarum:* Acrogynæ, 1916, **5,** 957–71.

[8] —, *op. cit.*, p. 967.

[9] In giving the habitat of this species, Stephani (*loc. cit.*, p. 967) says: "*India orientalis.* Mangalore". Obviously he is mistaken in the former part of his statement. Mangalore is on the west coast of India.

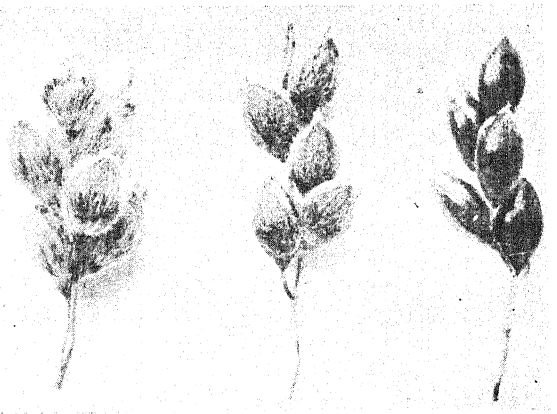
[10] Stephani, *loc. cit.*, p. 964.

SORGHUMS WITH FELTY GLUMES

THE distribution and inheritance of hairs in certain parts of the sorghum plant have been recorded in two previous papers.[1,2] Both the glumes can be hairy or 'glabrous'. When hairy the lemmas and the palea are also hairy. All glumes are hairy in some degree or other. The 'glabrous' glumes present a shiny surface with odd hairs and are fringed sparsely with hairs at the periphery. This sparseness is extreme when the glumes are tough and leathery. The hairy condition has been recorded as a monogenic dominant to the 'glabrous' (sparsely fringe hairy) condition.[3]

In cultivated sorghums the hairs are adpressed to the glume and are from 0·5 to 0·7 mm. in length. Against a background of shiny glumes of the type furnished by *Sorghum dochna*, these hairs glisten in the sun. There is a general tendency for the nodal band to be hairy when the glumes are hairy, but there are exceptions to this simultaneous manifestation. In wild sorghums the hairs are finer than in cultivated sorghums; in *S. sudanense* and *S. virgatum* the length is 0·3 to 0·4 mm. and in other varieties it is 0·5 to 0·6 mm.

A rare type of hairiness in which the hairs are longer (1·2 to 1·5 mm.) and give the glume a *felty* appearance has been met with in a cultivated variety from Tinnevelly, South India, belonging to the group *S. dochna* var. *burmanicum* (Photograph). Similar types of felty glumes are found to occur in some types belonging to *S. Roxburghii, S. caffrorum,*



Felty Glume | Hairy Glume | 'Glabrous' Glume

S. coriaceum and *S. cernuum.* When the glume is felty (long hairs) the hair length increases

in the panicle parts that could be hairy. Though the glume hairs are long, the hairiness on the nodal band retains the usual length (0·1 mm). After the milky stage the hairs begin to drop off.

The relationship of the felty glume to the ordinary hairy glume was pursued in a cross between the felty *S. dochna* var. *burmanicum* and another *S. dochna* which was merely hairy. The F_1 was felty and in the F_2 two segregating families gave a total of 156 felty to 51 hairy glumes.

A second cross was made between the felty glume and another *S. dochna* which was 'glabrous' (short hairs at the fringe). The F_1 was felty and in the F_2 two segregating families gave the following figures: 160 felty, 47 hairy, 49 'glabrous' (long hairs at fringes) and 17 'glabrous' (short hairs at fringes), a clear dihybrid ratio. An F_3 of 16 families was raised and they behaved as follows: One selection, fringes short hairy: pure. Three selections, fringes long hairy: two pure and one segregated giving 90 long and 33 short hairs at the fringes. Three selections hairy: two pure and one segregated giving 42 hairy and 15 fringes short hairy. Nine selections of felty glumes: three pure, two segregated giving a total of 164 felty and 55 hairy, two segregated giving a total of 186 felty and 58 fringes long hairy, two repeated the dihybrid ratio, the numbers being 131; 39; 38 and 11.

In wild sorghums the hairs are finer and smaller. This is to be expected as they are not as big and robust as the cultivated sorghums. Even in the wild sorghum there are long and short hairs. The gene responsible for the sparse manifestation of glume hairs ('glabrous') is rare in the wild sorghums. In a cross between *S. Stapfii* (long hairs) and *S. sudanense* (short hairs) a similar monogenic segregation was obtained, the numbers being 81 long and 29 short hairs.

From the above data it will be noticed that a dominant gene designated Gh is responsible for the hairy condition of the glume. Gene gh results in a virtually 'glabrous' glume, the fringes being hairy with stray hairs on the body of the glume. Another gene G accentuates the length of the hairs to a felty condition and is a monogenic dominant to gf giving the common hairy condition. Genes Gh and Gf act independently in inheritance.

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B. W. X. Ponnaiya.

Millets Breeding Station,
Coimbatore,
November 17, 1941.

[1] *Curr. Sci.*, 1939, **8**, 115–16.
[2] *Madras Agri. J.*, 1939, **27**, 210–14.
[3] *Jour. Madras Agri. Students' Union*, 1924, **12**, 1–17.

DEVELOPMENT OF GLANDULAR HAIRS IN *ORTHOSIPHON STAMINEUS* BENTH.

The plants belonging to the Family Labiatæ have long been famous for the various essential oils extracted from many of them for the manufacture of perfumes and medicinal preparations. The volatile oils, which impart to the plants their characteristic aroma, are secreted by different types of glands present on the several parts of the plant. The structure and development of these glands and a detailed study of their cytoplasmic inclusions are being investigated by the author.

In *Orthosiphon stamineus* numerous multicellular glandular hairs are present on the calyx, corolla, anthers, and around the base of the gynobasic style. Non-glandular hairs also occur along with them especially on the calyx and the tubular corolla. A well-developed glandular hair consists of a stalk composed of two to three cells and a shield-shaped head portion of eight cells which constitute the gland proper. The development of a glandular hair commences with the protrusion of an epidermal cell from the rest of its accompanying cells (Fig. 1). This cell divides by a periclinal wall into a glandular head-cell and a stalk-cell (Fig. 2). The stalk-cell divides again periclinally into a middle cell and a basal cell. The

head-cell divides anticlinally into two cells (Fig. 3). These cells divide further into four (Figs. 4 and 5), and then into eight cells (Fig. 6). The middle stalk-cell gradually

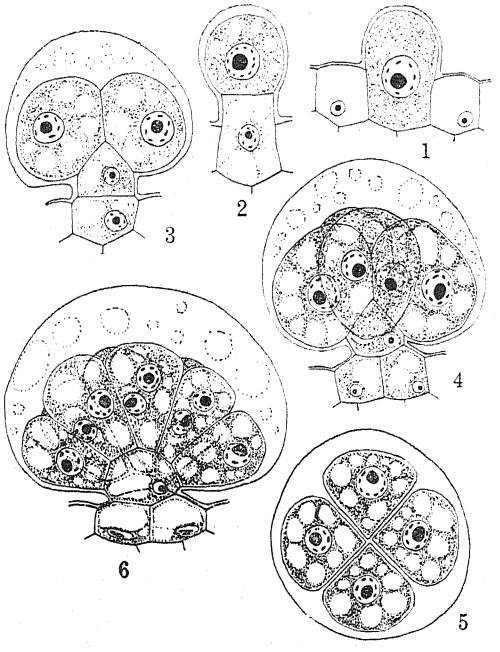


FIG. 1—Protruding epidermal cell. × 100.

FIG. 2—Division of the epidermal cell into a stalk-cell and a head-cell. × 100.

FIG. 3—Division of the head-cell into two cells. ×100.

FIG. 4—4-celled stage of the glandular hair. × 100.

FIG. 5—Transverse section of a glandular hair at the 4-celled stage. × 100.

FIG. 6–8-celled glandular hair. × 100.

bulges into the base of the glandular head-cells. The volatile oil is secreted beneath the cuticle, which becomes raised like a bladder over the gland cells, owing to the accumulation of secretion (Figs. 3, 4 and 6). The basal stalk-cell often divides into two cells by a radial wall (Fig. 4). The glandular hair is thus differentiated into a secreting region and a storage region. The volatile oil escapes into the atmosphere when the distended cuticle bursts under the pressure of its contents thus producing the characteristic aroma.

In conclusion the author feels indebted to Dr. M. A. Sampathkumaran, Professor of Botany, University of Mysore, for his kind criticism of the paper.

S. NARASIMHA MURTHY.

Department of Botany,
Central College, Bangalore,
October 29, 1941.

TADPOLES AS HOSTS FOR THE GLOCHIDIA OF THE FRESH-WATER MUSSEL

IT is well known that an obligatory period of parasitism on a suitable fish host is an important phase in the life-history of the fresh-water mussel. But are fish the only suitable hosts for the Glochidia to metamorphose into juvenile mussels? All accounts which we have, so far, on the development of the Unionidæ speak of the metamorphosis of the Glochidium encysted in the tissues of fish hosts only. Faussek,[1] Arey[2] and Herbers[3] utilised aquatic vertebrate hosts other than fish for studying the attachment of the Glochidia and their subsequent encystation in the tissue of the host, but there is no mention of the metamorphosis of the Glochidia in their experiments. On the other hand, Arey[2] definitely mentions that 'the larvæ of the fresh-water mussel cannot metamorphose without passing a semi-parasitic period buried in the superficial tissues of appropriate *fish hosts*' (Italics mine). Herbers utilised the tadpoles of *Rana* and *Pelobates*, but found that the Glochidia dropped off after some time without metamorphosis.

Attachment of the Glochidium to a host and subsequent formation of a cyst in the tissues of the host do not necessarily indicate that the host is an appropriate one and that the encysted parasite will metamorphose into the juvenile mussel. Glochidia may be made to infect species of fish and other aquatic vertebrate hosts which possess a natural immunity. In such cases the Glochidia drop off without metamorphosis. I find that the Glochidia can be made to attach themselves even to invertebrate aquatic hosts like the Glossiphonid leeches.

Recently, in the course of my studies of the Unionidæ, I infected the tadpoles of *Rhachophorus* and *Rana* with the Glochidia of *Lamellidens* and observed the metamorphosis of the encysted Glochidia into juvenile mussels. In the first series of my experiments I used very young tadpoles of *Rhachophorus* and later stages of those of *Rana*. The Glochidia encysted in the tissues of *Rana* failed to metamorphose, while those in *Rhachophorus* metamorphosed into normal juvenile mussels.

With a view to finding out whether this failure of the Glochidia to metamorphose was due to the harmful effect of the chemical substance which is said to be produced in the degenerating tail of the metamorphosing tadpole, or whether it was due to the dense pigment in the integument of the tadpoles of *Rana*, or to any specific natural immunity of the tadpoles, a second series of experiments were carried out with proper controls. In these experiments the tadpoles of *Rana* were infected in the different regions of the body including the thigh and the web of the hind limb. Tadpoles which had been kept in the laboratory for some length of time and had lost much of their pigment, as well as species of tadpoles which are normally with little or no pigment, were infected with Glochidia. The experiments showed conclusively that the dense pigment of the integument prevents the metamorphosis of the encysted larvæ, and kills them. Glochidia encysted on the thigh, web and other regions of the body with little pigment, as well as those encysted in the tissues of the pigmentless species, metamorphosed normally. In one instance I could actually observe the metamorphosing larva struggling slowly out of the cyst on the thigh and dropping out as the juvenile mussel.

In the case of the larvæ encysted in the densely pigmented regions of the body, examination of sections showed that the development proceeds to a fairly advanced stage, but later on, the mantle cavity of the larva is invaded by the pigment and becomes gorged with it, resulting in the arrest of the metamorphosis and subsequent shedding of the cyst. I have not yet determined whether the death of the larva is due to the chemical nature of the pigment or to its choking effect.

Other interesting features were also observed in the course of the work, particularly the very rapid repair of the wound after the dropping of the metamorphosed Glochidium, the movement of the surrounding tissue into position, to fill up the breach caused by the rupture of the cyst, being clearly perceptible under the microscope.

Further work is in progress.

R. V. Seshaiya.

Annamalai University,
November 10, 1941.

[1] Faussek, V., *Biol. Centralbl.*, 1895, **15**; *Zool.-Kongr.*, Berlin, 1901.

[2] Arey, L. B., *Biol. Bull.*, 1932, **62** ; *Jour. Morph.*, 1932, **53.**

[3] Herbers, K., *Z. f. wiss. Zool.*, 1913, **108.**

KTENOSTREPTUS SPECULARIS ATTEMS 1936—A CEYLONESE MILLIPEDE

Recently in looking up the literature on Indian Diplopoda I have come across a reference to *Ktenostreptus specularis* by Attems (1936) who says, "*Ktenostreptus specularis* has been found in Ceylon and in India (Lucknow)."

This millipede has never been found in Lucknow. The body of this millipede is jet black in colour, its antennæ and legs are yellow, and its size is about 1½ times larger than the biggest Lucknow millipede. In December 1930 I sent a collection of millipedes from several parts of India including a few specimens of *Ktenostreptus specularis* (which are obtained by me from Ceylon for purposes of comparison with the local forms) to Dr. Attems at Vienna. It appears some of these specimens got mixed up at the Naturhist. Museum, Vienna, and hence the error in Attems' work published in 1936.

There is, however, one point which needs further consideration. In describing *Ktenostreptus specularis*, Attems mentions that the

Lucknow specimen (male) has 54 segments and the Ceylon specimen (female) has 65 segments and the length of the millipedes is 16–19 cm. My own observations on these millipedes reveal that the length and the number of segments varies with individuals as follows:—

Female:

Specimen	A	18·5 cm.	67	segments including Collum & Anal ring.
„	B	18·7 cm.	67	„ „
„	C	19·1 cm.	67	„ „
Male:				
„	D	19·0 cm.	67	„ „
„	E	19·3 cm.	68	„ „
„	F	20·3 cm.	68	„ „

The present communication will also emphasize further the endemism of Indian Diplopoda which has been referred to by Attems (1936) who says, "only 6 or 7 species are common to two parts—Peninsula and Ceylon".

M. B. LAL.

Lucknow University,
November 24, 1941.

RAMANUJAN: HIS LIFE AND WORK

IN his review of G. H. Hardy's book on 'Ramanujan: His Life and Work', appearing in the July (1941) number of *Current Science*, Prof. Siddiqi says: "There is one remark of Prof. Hardy with which it is difficult to agree. Prof. Hardy says, 'I very much doubt whether Ramanujan, to the end of his life, ever understood at all clearly what an analytic function is'. It should be remembered that Ramanujan stayed at Cambridge for more than three years and *passed the Mathematical Tripos*. ..... However, if Prof. Hardy's conjecture is true, it does not speak much for the teaching of Mathematics at Cambridge which could not make a Ramanujan understand the nature of an analytic function at the end of a three years' course. We hardly think that Prof. Hardy himself would like to be forced to this conclusion".

It is incorrect to say that Ramanujan took the Mathematical Tripos, for, the B.A. Degree that he obtained at Cambridge was only a research degree. A life-sketch in the *Journal of the Indian Mathematical Society*, August 1919, says, "At Cambridge he was given the research degree and the frontispiece shows him in his academical robes."

Prof. Hardy himself observes in the collected papers of Ramanujan: "He wished indeed to qualify for a Cambridge degree as a research student but this was a formality".

K. CHANDRASEKHARAN.

Department of Mathematics,
University of Madras,
October 7, 1941.

I ACKNOWLEDGE my mistake, and gratefully accept Mr. Chandrasekharan's correction. However, I plead that my mistake was natural for various reasons.

(1) Before the last Great War, Cambridge academic life was dominated by the Mathematical Tripos, and every promising mathematics student went there for the Tripos. I was therefore under the impression that Ramanujan's Cambridge B.A. must have been due to his having taken the Tripos.

(2) The lowest research degree at Cambridge or any other University is that of M.Sc., and it would come as a surprise to most people that Ramanujan was awarded a research B.A. Degree at Cambridge.

I am not disputing the fact, but only explaining why the details about Ramanujan's degree escaped my notice. Both the quotations given by Mr. Chandrasekharan do not specify the 'B.A. Degree', but mention only the research degree. I assume with Mr. Chandrasekharan that they refer to the B.A. Degree. Anyway, one does not think much of degrees in connection with Ramanujan. They are immaterial. The main point for the purpose of my argument is, as I have explicitly stated in the passage cited by Mr. Chandrasekharan, that Ramanujan stayed at Cambridge for more than three years. During this time he must have met and talked with many mathematicians at Cambridge—not to speak of Prof. Hardy himself, whom he met almost every day.

RAZIUDDIN SIDDIQI.

Osmania University,
Hyderabad (Deccan),
November 17, 1941.

A NOTE ON THE LATE MR. DEV DEV MUKERJI'S MANUSCRIPT DRAWINGS OF THE AIR-BLADDER OF THE GOBIOID FISHES OF THE GANGETIC DELTA[1]

By SUNDER LAL HORA

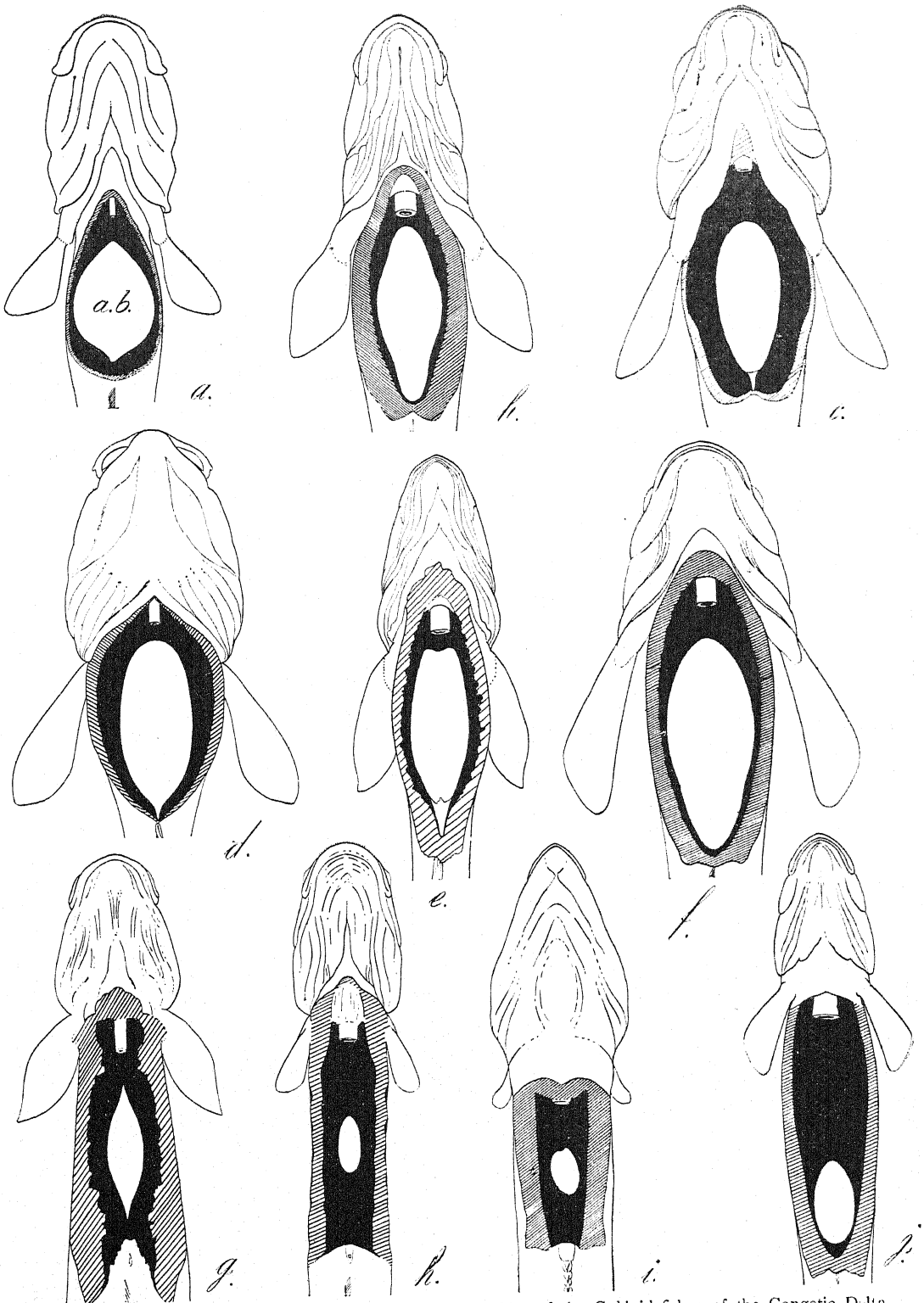
(*Zoological Survey of India, Calcutta*)

IN my[2] note on the modification of swim-bladder in certain air-breathing fishes of India, among other things, attention was directed very briefly to the correlation between the form and position of the bladder and the mode of life of the Gobioid fishes of the Gangetic Delta. In a foot-note it was stated that "Mr. Dev Dev Mukerji of the Zoological Survey of India is at present engaged in investigating the correlation between the structure of the air-bladder and the ecological factors in the case of Gobioid fishes in the Gangetic Delta". Mr. Mukerji had drawings made of the dissections of various species showing the position and extent of the air-bladder in each case, but before he could write his article the cruel hand of Death snatched him away in the prime of his life.[3] Recently Rahimullah[4] described the gas-bladder of the Gobioid fish, *Boleophthalmus boddarti* (Pallas), a common species of the Gangetic Delta, and it occurred to me that the publication of the late Mr. Mukerji's manuscript drawings with such comments as I am in a position to offer, may be of some use in the elucidation of the correlation referred to above and hinted at by Rahimullah also.

An ecological zonation of the Gobioid fishes[5] of the Gangetic Delta and an account of their bionomics has already been published,[6] but it may be worthwhile to reiterate here that of all the Gobioid species found in this habitat *Glossogobius giuris* (Ham.), *Gobiopterus chuno* (Ham.) and *Brachygobius nunus* (Ham.) are the most aquatic forms, though even they are capable of living out of water for shorter or longer periods depending upon meteorological conditions. *Eleotris fusca* (Bl. and Schn.) and *Butis butis* (Ham.) are usually found near the edges of ponds and other collections of water in thick vegetation, but are more or less aquatic in their mode of life. They are, however, more tenacious of life than either *Glossogobius, Gobiopterus* or *Brachygobius*. *Apocryptes bato* (Ham.), which is found in burrows on muddy banks near lowtide mark and in outlying shallow portions of the tidal pools, etc., and *Stigmatogobius sadanundio* (Ham.), which is found in crab holes along the banks of pools and narrow channels, live under water for most of their time, though they may sometimes be exposed to aerial conditions at low-tide. *Odontamblyopus rubicundus* (Ham.) and presumably *Trypauchen vagina* (Bl. and Schn.)[7] also live in deep burrows along the sides of streams near low-tide mark and in tidal pools which may dry up occasionally for a short period. *Pseudapocryptes lanceolatus* (Bl. and Schn.) lives in deep burrows in spring-tide pools, which dry up for days together in between the high tides. *Boleophthalmus boddarti* (Pallas) is found on muddy banks between tide marks, but the almost terrestrial form extensively met with in the Gangetic Delta is the mud-skipper, *Periophthalmodon schlosseri* (Pallas).

Correlated with the differences in the respective mode of life of the various species as indicated above, it is interesting to note that the physoclist air-bladder of *Glossogobius, Gobiopterus* and *Brachygobius* is fairly extensive and occupies a considerable part of the body cavity. The air-bladder of *Glossogobius giuris,* which lives in comparatively deeper and more permanent pieces of water, is relatively much larger. In shore forms, such as *Eleotris fusca* and *Butis butis* and *Stigmatogobius,* which lives in shallow and relatively broad holes, the air-bladder is still extensive, but in *Apocryptes bato,* which lives in burrows under water or near low-tide mark, the bladder has become spindle-shaped and considerably smaller. In *Odontamblyopus* and *Trypauchen,* both of which live in deep burrows, the bladder is greatly reduced, but is still situated in the middle of the abdominal cavity, a stage of reduction already indicated in the spindle-shaped bladder of *Apocryptes bato* (Ham.), while in *Pseudapocryptes,* which is more subject to desiccation than the species mentioned above, the reduced bladder is situated in the posterior part of the body cavity. I (1935,

[1] Published with the permission of the Director, Zoological Survey of India.



The late Mr. D. D. Mukerji's drawings of the air-bladder of the Gobioid fishes of the Gangetic Delta.

a—*Glossogobius giuris* (Ham); b—*Gobiopterus chuno* (Ham.); c—*Brachygobius nunus* (Ham.); d—*Eleotor fusca* (Bl. & Schn.); e—*Butis butis* (Ham.); f—*Stig-matogobius sadanundio* (Ham.); g—*Apocryptes bati* (Ham.). h—*Odontamblyopus rubicundus* (Ham.); i—*Trypauchen vagina* (Bl. & Schn.); j—*Pseudapocryptess lanceolatus* (Bl. & Schn.).

p. 336) did not find any air-bladder in *Boleophthalmus* and *Periophthalmodon*, but Rahimullah (*loc. cit.*) has described and figured a small, ovoid or ellipsoidal bladder in *Boleophthalmus* lying freely in the body cavity. There seems to be some mistake in Rahimullah's account where he correlates the presence or absence of the air-bladder in *Boleophthalmus* and *Periophthalmus* with their respective mode of life and states that "though the habits and habitats of *Boleophthalmus boddarti* (Pallas) are more or less similar to those of *Periophthalmus*, a small gas-bladder in *Boleophthalmus* is associated with its more pronounced terrestrial mode of life. As is well known and as has been stated above, the mode of life of *Periophthalmus* and *Periophthalmodon* is much more terrestrial than that of *Boleophthalmus* and this is further borne out by the fact that the air-bladder is completely absent in the two terrestrial genera of the Gangetic mud-skippers.

A comparison of the late Mr. Mukerji's figures with the ecological conditions under which the respective species live makes it abundantly clear that the reduction and finally the absence of air-bladder in the Gobioid fishes of the Gangetic Delta are definitely correlated with the progressively terrestrial habit of the species. Attention may here be directed to the fact that in the fishes of the hill streams[8] a similar reduction of air-bladder is induced by the pronounced ground-habit life of these fishes. Thus one is led to the conclusion that adaptation to the requirements of some important factor in a habitat is the main inducement for the structural modifications undergone by allied organisms living under diverse or apparently similar conditions.[9]

[2] Hora, S. L., *Curr. Sci.*, 1935, **3**, 336.
[3] —, "Obituary, Mr. Dev Dev Mukerji (1903–37)," *Ibid.* 1937, **5**, 439.
[4] Rahimullah, M., *Ibid.*, 1941, **10**, 440.
[5] The nomenclature used here is after Dr. F. P. Koumans "Gobioid Fishes of India," *Mem. Ind. Mus.*, 1941, **13**, 203.
[6] Hora, S. L., *Comptes Rendus du XII Cong. Internat. Zool.*, pp. 841–63 (Lisbon, 1935).
[7] Though *Trypauchen vagina* is found in the estuaries of the Ganges, neither the late Mr. Mukerji nor I had any occasion to make observations on the living specimens.
[8] Hora, S. L., *J. Bombay Nat. Hist. Soc.*, 1930, **34**, 374.
[9] —, *Phil. Trans. Roy. Soc. London*, (B), 1930, **218**, 171.

RESPIRATORY ENZYMES AND THE BIOLOGICAL ACTION OF THE VITAMINS—A SYMPOSIUM

Report of the Proceedings

BY FRITZ SCHLENK
(*University of Texas, U.S.A.*)

A SYMPOSIUM dealing with the problems on Respiratory Enzymes and the Biological Action of Vitamins, was conducted jointly by the University of Wisconsin and the University of Chicago, from September 11–17, in which many outstanding men in the field took part. The enzymes were discussed mainly in the Madison section, the vitamins, subsequently at Chicago. The participants were accommodated in the splendid dormitories of the Universities, an arrangement which provided opportunities not only for establishing personal contacts but also for holding intimate discussions on subjects of mutual interest.

The programme included 28 papers on various aspects of the subject and open discussions on (1) Phosphorylation, (2) Hydrogen transport, (3) Tumor respiration, (4) Bacterial respiration and (5) Animal tissue respiration.

The most outstanding events were the lectures given by O. Meyerhof, T. R. Hogness, C. F. Cori, C. A. Elvehjem, T. D. Spies, R. J. Williams and V. duVigneaud.

The splendid introductory talks of O. Meyerhof at Madison and C. A. Elvehjem at Chicago were general reviews on carbohydrate metabolism and on the biological action of the vitamins, respectively.

The lectures given in Madison will be published very soon by the University of Wisconsin Press, and there is every hope that the Chicago lectures will also be published.

The Symposium was supported by funds from both the Wisconsin Alumni Research Foundation and the Abbott Laboratories. The sessions at Chicago formed a part of the University of Chicago's semicentennial celebration.

REVIEWS

The Identification of Molecular Spectra. By R. W. B. Pearse and A. G. Gaydon. (Chapman and Hall, London), 1941. Pp. viii + 221. Price 42*sh.* net.

Anyone who has worked with vacuum tubes knows how persistent are the unwelcome bands from unsuspected impurities lurking after even the most careful purification, the CO and CN bands being the most frequent. Their presence is annoying enough when they hide important atomic lines but when one is trying to locate the bands due to a molecule whose spectrum has not been previously studied thoroughly, they may lead the unwary investigator into Pickwickian discoveries. It is, therefore, a very necessary aid to have a handy list of all known band systems. Apart from this negative kind of service which such a list can render there are positive uses also. If an unknown system appears with a known system we have an important clue to its origin. Also, whereas now we are able spectroscopically to analyse any specimen as to the elements it contains by means of its atomic spectrum, we may expect in the near future to find a similar role played by band spectra in the analysis of compounds, particularly so as regards the electronegative constituents. Although a table of band systems is thus a pressing need, we have not so far had a serviceable list except for the information to be found in such books as Jevons's *Report on Band Spectra* and the *Tabelles Annuaires.* The present writer had made a list of the most frequently occurring systems for his own use from the above sources, but the list was not extensive and additions were being made only when some system occurring on his plates proved intriguing and was at last identified. In the case of atomic lines we have excellent tables, but the field of band spectra was so far not provided with similar guides. This defect has been remedied with conspicuous success by the tables now under review. The problem of facilitating ready reference without making the list so extensive as to favour chance coincidences, thus defeating its very purpose, has been admirably solved by giving two lists—one in order of wavelengths for the most important heads of all the systems dealt with and another in order of the chemical symbols of the molecules wherein most of the known systems are collected under the corresponding compounds. The most intense head of a system to be identified is looked for in the first list according to its wavelength and knowing the probable emitter from this, its whole spectrum is then found from the second part and if all the bands to be expected under the conditions of the experiment are found, the emitting molecule can be identified with certainty. The authors have further enhanced the value of a mere list of wavelengths—by the way, this list itself is an advance in that wave-lengths of heads are consistently given to 0·1 Å—by giving information about the intensity, appearance and conditions of occurrence. On examining the list, we have found only one thing to regret, *viz.*, that in many cases only the (0, 0) band is listed so that if by reason of the region included in a plate this particular head is not present, identification becomes difficult. In a very few cases the band origin has been given instead of the head, but it is only in one or two instances that we have found the origin listed but wrongly quoted as a head. It is not also possible from these tables alone or from the references included in them, to find whether a head suspected to be a new member of a known system has been previously observed or not. No information is also to be found regarding the formula representing a system or the heat of dissociation of any state. Of course these are not necessary for identification but would be useful in other ways and it is always pleasant to be able to find some required information without too much search amidst the literature and without too much trouble in collecting references. If we can therefore venture on a suggestion to increase the value of the work, it will be to recommend that the (0, 1), (1, 0), etc.. heads may also be entered, particularly if they are rather distant from the (0, 0) band. Formulæ and heats of dissociation would also be welcome as also information regarding the rotational analysis where it exists. The plates given at the end of the book are a very valuable feature while the hints regarding sources and

other experimental details are quite welcome, particularly so since they embody the results of extensive research experience. Apart from a feeling that the price is rather heavy for a poor country like India, we have nothing but praise and welcome for these extremely useful tables. T. S. S.

Electrodynamics. By Leigh Page and Norman Ilsley Adams (Jr.). (Chapman & Hall, London), 1941. Pp. xii + 506. Price 32*sh.*

This book is designed as an advanced text on the theoretical aspects of electrodynamics, treated consistently from the relativistic standpoint. It may be said at once that the book is a valuable addition to the existing number of text-books on the subject. The exposition is throughout on a uniformly high level of precision and clarity, and there are plenty of little bits—"einzelheiten"—which catch the eye even at a casual glance. The treatment of the subject proper is prefaced by two chapters dealing with vector analysis and special relativity respectively. In the first chapter three-dimensional vector analysis is treated at some length, modelled after the exposition by Gibbs, while four-dimensional vector analysis is postponed to the penultimate chapter. The treatment of special relativity in the second chapter is a slight modification of the method adopted by Milne in his development of kinematical relativity. It may be doubted whether it is advisable to compel the student to base his study of electrodynamics on a mode of development of relativity the implications of which have not yet become fully clear and which has not yet received the unqualified approval of physicists in general. The fundamental equations of the electromagnetic field are derived from an emission theory which ascribes physical reality to the lines of force and regards each line of force as 'a dense linear aggregate of moving elements' emitted by an element of charge. The authors give it as their opinion that this is the only logical mode of development of electrodynamics. One feels that this is perhaps a matter of opinion only and that, after all, there is something to be said for the phenomenological method, particularly from the pedagogic standpoint. Further the emission theory developed by the authors introduces a new entity into the field—the moving elements, whose physical nature remains obscure. These and other features, together with the method of development of special relativity make the initial development of electrodynamics as presented in the book appear somewhat formidable, though perhaps this may really be so because of a smaller number of initial hypotheses made.

When the fundamental equations have once been established the development proceeds smoothly, and a variety of topics is covered including the classical theory of the spinning electron, the motion of ions in uniform electric and magnetic fields with applications to metallic conduction, waves guided by perfect and imperfect conductors, and the axially symmetric radiation fields due to the oscillations of spherical and spheroidal conductors. The account of the application of general dynamical methods in the last chapter is quite good and includes applications to the motion of a point charge in a static electromagnetic field and to the theory of cosmic ray trajectories.

We have no doubt the book will be very useful to all serious students of electrodynamics as well as to all who are interested in the study or teaching of mathematical physics. V. R. T.

Differential Equations. By G. S. Diwan and D. S. Agashe, Bombay, 1941. Pp. ix + 316.

Advanced mathematical text-books by Indian authors are somewhat rare and we have had to depend for the most part on English, American and other foreign books. We have, therefore, no hesitation in offering a warm welcome to the present text on differential equations by Messrs. Diwan and Agashe. It covers, somewhat rigidly, the traditional syllabus in the subject as prescribed in most of our Universities. Within the restricted limits which the authors have set themselves, they have taken pains to provide full explanations and also large collections of representative examples for practice. The printing and general get-up of the book are quite good and compare favourably with those of the best foreign publications.

It is to be regretted that the authors have followed too closely in the time-honoured tradition of the older English text-books, which place an undue emphasis on the formal side of the subject, to the detriment of the more fundamental and practical aspects. Thus in treating the particular

integral of a linear differential equation with constant coefficients, the authors reproduce the customary elaborate set of rules pertaining to several hypothetical cases, while in practice the method is effective in only two cases, *viz.*, when the right-hand side is of the form x^n or $x^n e^{ax}$. One would prefer, for example, the simple and unitary treatment in de la Vallee Poussin's *Cours d'Analyse*, especially as the time and labour spent in learning the various formal manipulations involving inverse operators is scarcely commensurate with the resulting gain. No mention is made of existence theorems, graphical and numerical methods of integration or integration in series. As the latter methods are of main importance in the applications to many problems in analysis as well as to problems in mathematical physics and engineering and as the discussion of the existence of a solution is an indispensable preliminary to the application of such methods, the complete omission of these topics is somewhat surprising.

Some remarks of a general nature may not perhaps be out of place here. Given a differential equation the questions that arise are (1) whether a solution exists and whether it is uniquely determined by the given conditions, (2) whether the solution can be expressed in terms of known functions, and if it is not, the nature of the function defined by the differential equation, and (3) whether we can approximate to the solution to a degree sufficient for the needs of practical problems. A reasonably liberal course on differential equations must touch, however lightly, on all these points, but it must be admitted that few of the existing texts meet these requirements. It may be urged, and with justice, that text-books are written in conformity with the demands of the official curricula in the subject and cannot afford to deviate therefrom. True, text-books when written are guided by the syllabus, and syllabuses when framed are fashioned on the existing texts and so the pernicious circle perpetuates itself! The dead-hand of an ancient and fossilised syllabus still oppresses us and we are still content with teaching our boys nothing more than a set of rules for solving a few types of artificially constructed differential equations which bear little resemblance to those which naturally present themselves either in pure mathematics or in mathematical physics and engineering. It is high time that the present curricula were transformed into something more liberal, more educative and more useful. One might perhaps then look forward to the appearance of texts which possess something of the freshness and flavour of the expositions by Bieberbach, Courant-Hilbert or Horn. V.R.T.

The Scientific Photographer. By A. S. C. Lawrence. (Cambridge University Press), 1941. Pp. x + 180. Price 18*sh.*

The book attempts to give a short account of the possibilities and limitations of photography, according to the author's ideas, primarily for the scientific worker, but also for the serious amateur who has an elementary knowledge of Chemistry and Physics.

Although photography has been employed in a number of different ways in the past few years, for instance in detecting new radiations and in fixing tracks, there does not appear to be adequate use made of photography in scientific laboratories. It appears that there is also no organized attempt yet made for using the cinematography either for research or for serious teaching.

The main purpose of this work seems to be to help workers in science laboratories. The usual descriptions of the numerous appliances and operations are given as briefly as possible, laying considerable stress on such items as are bound to be of much value in scientific photography, like lighting, angles, depth, etc. Most of them are discussed in an interesting manner and with an eye on usefulness.

Some scientific applications of the cine-camera are mentioned. A suggestion is made that the time is rapidly approaching when a film service will be an integral part of every big library, especially of those attached to technical establishments, so that anyone requiring information will be supplied with film copies of anything that is required. With the increasing cost of equipment of a varied nature in the laboratories, it is suggested that numerous demonstrations, too complicated to be carried out at lectures, should be filmed and shown at every university in the world every year. This is a very vital suggestion and presumably very economical but not until the authorities concerned are able to realize the power of the film for education.

The portions dealing with the correction of defects like under-exposure, over-develop-

ment, etc., are particularly interesting. A special section is devoted to record photography. There is on the first line of page 143 a mistake, obviously due to oversight. The figures and pages referred to should be 50 (*a*) and (*b*) and 87, 89. The last chapter on some scientific applications of photography and the Bibliography supplied at the commencement of the book enhance its value.

G. R. P.

The Ecology and Control of the Forest Insects of India and the Neighbouring Countries. By C. F. C. Beeson. (Forest Research Institute, Dehra Dun), 1941. Pp. ii + 1007. Price Rs. 14.

In planning this book, the author, as he states, in his Preface, was greatly helped by the official opinions of forest departments and many individual suggestions. It must be said at once, that the author, on his part, has seen to it, that the book meets admirably the needs, not only of the divisional officers and his staff and the lecturers in forest colleges, but also of research workers and entomologists in general.

The section dealing with the history of Forest Entomology in the Indian Region, makes very interesting reading; it only confirms as in the case of Agricultural and Veterinary and Medical Entomology that the progress in the development of Entomological research in India, though slow, has been steady and on correct lines and that a sound foundation has been laid for further progress, for which there is wide scope as well as need.

This book of 1007 pages is divided into two principal parts: (*i*) The Ecology of Forest Insects, and (*ii*) The Control of Forest Insects. In Part I (pages 19 to 792) a detailed and scientific classification of insects is dealt with, in addition to presenting fairly exhaustive accounts of the life-histories, habits, natural enemies, economic importance and other associated factors. The families of beetles, such as Cerambycidæ, Curculionidæ and Scolytidæ, which include most of the common species of wood borers, naturally occupy the greater portion of the group Coleoptera. The orders Diptera and Hymenoptera, including a large number of very important natural parasites of harmful insects, are very well represented; even mosquitoes under Diptera and honey bees under Hymenoptera, are dealt with, to the extent they interest forest officers. The order Isoptera, comprising many injurious species of termites or white ants, whose activities are well known, claims some 30 pages. Lepidoptera, the group of butterflies and moths, stands equal in importance to Coleoptera, in forest entomology and has, naturally, been handled exhaustively by the author. Information about the most common of the bugs (Rhychota) affecting forest trees, specially in the nurseries, will be found extremely handy and up-to-date by the divisional officers stationed far away from head-quarters.

In Part II, the all-important factor of insect control has been dealt with under two simple and clear heads, namely natural control and artificial control. The work of natural control, largely influenced by meteorological factors like temperature, rainfall, humidity, wind, sunshine, etc., that are beyond human power, and others like food in quantity and quality and finally by such of those plant and animal organisms living a parasitic life, has been described in a very lucid manner. Under artificial control, the author has adopted the conventional method of classification and has touched on most of the latest developments in the use of contact poisons, repellents, stomach poisons, fumigants and preservatives. Forest officers, no doubt, have to specially thank the author for the very useful tips given to them in the control of some of the most important and common injurious insects. Biological control of harmful insects and noxious weeds has not been forgotten and forms an interesting and instructive sub-section.

The volume has been very neatly got up; the numerous line drawings and photographs, descriptive charts and graphs together form an additional attraction to the reader.

Synoptic Tables for the Identification of the Full-Grown Larvae of the Indian Anopheline Mosquitoes. By I. M. Puri. Health Bulletin No. 16, Malaria Bureau, No. 7. (Manager of Publications, Government of India, Delhi), 1941. Price As. 14 or 1*sh.* 3*d.*

The main section of this bulletin, as the title indicates, consists of identification keys for full-grown *Anopheles* larvæ occurring in India. None is better qualified to draw up such keys than the author himself, for more than anybody else he was responsible for our present thorough knowledge of chœtotaxy of Indian larvæ.

Naturally, the characters employed in the keys are absolutely diagnostic and are also very easy to examine. The main table is

amply illustrated by clear diagrams and by cleverly keeping all letter press to only odd pages and by grouping the appropriate illustrations on the opposite pages, the value of the illustrations has been very much increased.

Besides the main synoptic tables, the bulletin contains an introductory section in which brief hints are given on collection, preservation and examination of larvæ, and a concluding section giving notes on some additional diagnostic features and breeding habits of all the species. The fact that in this fourth edition, no major changes were found necessary at all, except the inclusion of the newly discovered differential characters of *A. subpictus* and *sundaicus* shows that the characters used in the keys are well chosen and have stood the test of critical use by several workers.

One comment may, however, be made. Is it any longer necessary to include the five regional tables? For instance, the two tables relating to Peninsular India, and Assam, Burma, etc., each have 34 and 30 species respectively out of the 42 species contained in the main table, and the descriptive matter relating to them is almost an exact repetition in all of these tables. Further, any new worker using the regional tables would any way have to refer back to the pages of the main table to consult the excellent illustrations. Regional keys would no doubt be useful, but they must be limited to very localized areas, doing which is obviously impossible in a work like this. For instance, at Pattukkottai, in South India, not more than 12 species have been met with, while the regional table for Peninsular India contains 34 species and it is as easy for any one to consult the main table as to consult the regional one. It would, of course, always be necessary to include, as has been done, complete lists of all species occurring in particular provinces.

One of the most useful and indispensable handbooks for malaria workers in India.

T. R. R.

The Sugar Technologists' Association of India, Cawnpore, *Year Book*, 1940–41.

This useful Annual reviews the working of the Indian cane sugar factories publishing their names, manufacturing returns, recovery graphs and a synopsis of the figures for comparison. Data relating to milling and other machinery of the reporting factories and a list of cane sugar factories and refineries are appended.

Out of 151 factories which operated during the year, only 74 sent their manufacturing returns. The season was short this year, with 113 working days as against 139 days in the previous year. The quality of cane was slightly better than in the last year; the average pol per cent. cane was 12·18 in 1940–41 as against 11·72 reported in 1939–40. The production of sugar is estimated at 10,82,500 tons this year with a recovery of 9·75 per cent. of the cane as against 9·37 per cent. in 1939–40. Factories also showed marked improvement in milling efficiency, recoveries being highest in February and March.

The average milling efficiency was 91·2 per cent., boiling house recovery, 87·2 per cent. and overall recovery 79·5 per cent. of the sugar in the cane. But till these figures are improved to M.E. = 95 per cent., B.H.R. = 90 per cent., O.R. = 85 per cent., sugar factories in India will be far behind those in other countries, in efficiency. With an average fibre content of 16·1 per cent. cane, extra fuel used as coal and wood have been 0·5 per cent. and 2·8 per cent. of cane. Attempts should be made to send dry bagasse to the boilers, when the need for extra fuel would gradually disappear.

Some factories especially in east U.P. have shown very good results while others in South India and States lag behind. "The necessity for improvements should be realised by owners and technical staff."

In order that the industry should reach a high degree of efficiency, it is essential that an equal if not more attention be paid to the growth, harvest and transport of sugarcane.

An improvement in the quality of cane and its harvesting at the proper time is of more consequence than even improvements in the factory. The chemical staff should be able to help in the field too.

The *Year Book* would be complete with a sugarcane map of India with a table of acreages and harvests.

Y. K. RAGHUNATHA RAO.

THE FORMATION AND THE RECLAMATION OF THUR LANDS IN THE PUNJAB

The Formation and the Reclamation of Thur Lands in the Punjab. By M. L. Mehta. (Research Publication of the Punjab Irrigation Research Institute). Pp. 52 and 17 plates. Price Re. 1–1–0.

LARGE tracts of land in the Punjab are being thrown out of cultivation every year, as a result of continual deterioration of land due to thur. In the Rechna, Chaaj and Bari Doabs, during the years 1927 to 1937, over 5 lakhs of acres of cultivated land went out of cultivation; the present rate of deterioration is about 25,000 acres per year, and taking the worth of an acre at Rs. 200, every year there is a loss of about half a crore of rupees.

In large areas of the Punjab there is invariably a salt-bearing layer of soil some distance below the natural surface, salts being usually present as zones of accumulation in the irrigated areas, with a more uniform distribution of salts in unirrigated areas. Where thur should develop as a result of the irrigation of an area having a salt layer in its profile, the obvious source of the salt is the salt layer. A rising water-table touching a soil crust of 10 or more feet thick, ceases to rise and at the soil surface there are no signs of water-logging. When water-table reaches a depth of about four feet from the surface loss of water by evaporation does not take place and hence a deeper water-table is unlikely to contribute salts to the soil surface. In areas of high water-table, still under cultivation, there are zones of salt accumulation and in lands gone out of cultivation due to thur, much more salt is found than could be ascribed to the water-table as its source indicating that even in areas of high water-table, it is not a very contributory element to thur formation. In the Punjab, the main salt present in the soil is sodium sulphate, which during winter nights, when humidity and temperature conditions are very suitable, absorbs considerable quantities of moisture from the atmosphere and by day, conditions being suitable for evaporation, a moisture gradient is established in the soil with the consequent movement of salt towards the surface. In the *kharif* season, conditions not being favourable, no such movement of salt takes place.

On all the branches of the Lower Chenab Canal, where thur is on the increase, the intensity of irrigation during *kharif* has increased, the depth of water used for irrigating *kharif* crops has decreased from 4·6 feet in 1907 to 2·5 feet per acre in 1936. Investigations carried out in the Punjab Irrigation Research Institute have shown that in *kharif,* salts are either stationary or have a downward movement, an upward movement of salts occurring only in the *rabi* season. Occurrence of thur under the present delta indicates that the upward movement of salts is predominant, resulting in zones of accumulation of salts near the surface, with the consequent transformation of land into thur at all places where these zones are sufficiently near the surface, for a concentration of salt to take place by evaporation. Increase of *kharif* irrigation and decrease in the amount of water used per acre have thus tended to an increase in the area going out of cultivation.

Soil deterioration takes place in two stages, the first stage consisting of an accumulation of salts, the second of the alkalisation of the soil. In normal soils clay is mainly present as calcium clay which when brought into contact with a solution of sodium sulphate or sodium chloride is transformed to an alkaline sodium clay. The longer the land is left unreclaimed, the greater will be the development of alkalinity rendering reclamation difficult and ultimately economically impossible. In a very alkaline soil, clay becomes deflocculated and the soil impermeable to water leading to difficulties in leaching and rendering the soil unsuitable for growth of normal crops.

Soils having a soluble salt content of 0·2 per cent. or less and a pH value not

higher than 8·5 were found to be capable of growing normal crops and giving normal yields; when the pH value lay between 8·5 and 9·0, land could be reclaimed with one rice crop followed by berseem, or senji, sugarcane and wheat or cotton, when the pH value lay between 9·0 and 9·5, two rice crops could reclaim such lands. When the salt content is over 0·2 per cent. but the pH value is less than 9·00 the soil is known as 'thur' and a rice crop reclaims the soil, gram, berseem, and senji can be grown in the *rabi* and sugarcane or cotton in the following *kharif*. When the pH value is greater than 9·5, with or without high salt content, the soil is known as 'rakkar' soil and reclamation of this soil is not economical. It is advisable to exclude such 'rakkar' soils from reclamation or new irrigation projects.

Land to be reclaimed is divided into ¼-acre-plots with the main water-course running through the middle of the field. Water is made to stand in the fields to a depth of four inches, from the first week of April to about the beginning of May. Field drains or means for pumping drainage water are provided in areas where the water-table is about 6 feet from the surface. 'Sathra' variety of rice is grown on fields where there has been rapid percolation and salts have been washed down. The 'Sathra' variety of rice was also found to fit in well, in areas where there is limited water supply. 'Sathra' does not require irrigation after the 10th July and other fields which have been under leaching are planted about this time with either the 'Sathra' or the 'Jona' variety of rice followed by hemp, gram, berseem or senji. Nearly 50 acres of 'thur' land can be reclaimed on one cusec of water. Leaching is very rapid in soils where the salt content is high and alkalisation is low. Though the reclamation is more easily effected, as water does not sufficiently stand in the rice fields, the yield of rice becoming low reduces the profit on reclamation. To obtain normal yields of rice under these conditions and to limit the water used to that required for actual removal of salts, the *barani* hill varieties of rice, requiring less water are introduced in such areas.

Yields of rice from reclaimed area were found to be higher than yields from normal soils in the neighbourhood and yields of rice even seven years after reclamation were found to be above normal. It was calculated, from a scheme for commercial reclamation, based on the work at Chakanwali Reclamation Farm and on seven years' 'data' in Zemindar's fields, that, if prior to reclamation land was worth Rs. 80 per acre, its value after reclamation would rise to Rs. 200 per acre. The total expenditure on three years, on reclamation in an area of 25 acres of thur land was found to work out to Rs. 1,872, the income during the period being Rs. 2,669.

Experiments have conclusively shown that salts can be removed from the soil, by the growth of rice and the land so reclaimed can produce good crops of cotton, wheat or sugarcane well over a period of 7 to 8 years without exhibiting any signs of deterioration. But it is essential to mark out at the outset, deteriorated or danger zones, and apply to such areas what Dr. McKenzie Taylor terms the 'Basin System of Irrigation' which washes out the salts to the underlying sand layers. It is also found from the available evidence that rice need be introduced only at long intervals of nine years or more.

The Punjab Province is greatly indebted, as Mr. Mehta observes at the very commencement of the paper, to Dr. McKenzie Taylor for all his guidance in the experimental work and for the evolving of methods for permanent reclamation of deteriorated lands and the development of new project areas.

C. GOPALAKRISHNAN.

CENTENARIES

Birkbeck, George (1776-1841)

GEORGE BIRKBECK, the founder of the Mechanics Institute, was born at Settle, Yorkshire, January 10, 1776. He received the rudiments of education at a village school. He displayed an early predilection for mechanical and scientific subjects, which led him to select the medical profession and he became an M.D. of Edinburgh in 1799.

In November 1799 he became professor of Natural and Experimental Philosophy in the Andersonian College at Glasgow. There was at that time no maker of scientific instruments and he was obliged to have them made by ordinary workmen. He had employed a tinman to construct a model of a centrifugal pump. While surrounded by the workmen in the cellar which was the workshop, he was struck with the idea of giving a course of lectures for the scientific instruction of mechanics. In March 1800 he communicated his wishes to the trustees of his College, who regarded the proposal as visionary!

Hence, at the close of 1800, he himself took the initiative and circulated a printed invitation in the chief manufacturies of the town, offering free lectures. The number who accepted this offer was at first not large and the first lecture was attended only by 75 persons. But it gave so much satisfaction, that the number exceeded 500 in the fourth lecture. This was the beginning of the education of mechanics.

In 1800 Dr. Birkbeck settled in London. While he developed a lucrative practice, he did not lose his interest in popular education. In 1820, he gave a free course of evening lectures and in 1823 he took part in the foundation of the London Mechanics Institute, which was later named after him. He was the president of this school till his death.

Birkbeck died at his residence in Finsbury Square December 1, 1841.

Don, David (1800-1841)

DAVID DON, a Scottish botanist, was born at Forfar in Scotland, December 21, 1800. His father was in charge of the botanical garden at Edinburgh, and this led David to acquire a considerable knowledge of botany even while young. In 1819 he was employed as librarian and curator by Mr. Lambert of London who had at that time a large collection of plants.

One of his earliest publications was *Description of several new or rare native plants found in Scotland chiefly by the late Mr. George Don of Forfar.* He followed this up by several papers contributed to the *Transactions* of the Linnæan Society. His accurate description of plants earned him a reputation and in 1822, he was appointed librarian of the Linnæan Society and he was appointed professor of botany in the King's college in 1836.

As librarian of the Linnæan Society, he used his opportunity to make considerable contributions to the *Transactions* of the Society and his papers number as many as 52. He was particularly attracted by the collection of Indian plants and in 1825 he published a description of the plants of Nepal under the title *Prodromus florœ Nepalenses.*

Though his constitution was strong and robust, he developed a malignant tumour on his lip, of which he died eventually, December 8, 1841.

University Library, Madras. S. R. RANGANATHAN.

SCIENCE NOTES AND NEWS

Activity Coefficients of Reducing Agents.—In a series of papers on the 'Thermodynamic study of bivalent metal halides in aqueous solutions', Stokes and Robinson (*Trans. Far. Soc.*, 1941, 37, 419) have described a simple modified form of apparatus for using isopiestic method to determine the activity coefficient of ferrous chloride using an inert atmosphere to prevent the oxidation of the salt. The special feature of this method is that the apparatus can be employed even for the preparation of ferrous chloride starting from iron and hydrochloric acid, thus preventing the oxidation completely. It has been found that the activity of ferrous chloride occupies a regular position in the series: manganese, iron, cobalt and nickel chloride. M. R. A.

Investigations on the Cold Storage of Potatoes.—One of the major problems connected with the cultivation of potatoes in India relates to the storage of the tubers over the fairly long period of dormancy required by them before they can be used for seed. As is well known the potato has to be kept for some two and a half to four months (depending upon the variety, the stage of maturity, and the season of the year) and then alone used for planting. Very large quantities of ordinary table potatoes also have to be stored likewise for varying periods in order to avoid a slump in the market and to obtain the higher prices which rule later in the season. A good deal of loss due to storage pests, dry and wet rots and driage takes place during such storage and

in the present methods of storage, more or less at the atmospheric temperature, which are known to and practised by the cultivator this loss is very high; in the summer months especially the loss is much higher still and is almost ruinous. The loss is seldom less than 25 to 30 per cent. and is known to go up as high as 80 per cent. Tubers stored for use as table potatoes begin to germinate and suffer in quality, adding thereby to the other losses.

The possibility of keeping potatoes under cold storage in India and the conditions of temperature most suitable for this purpose have been the subject of special investigation by the Imperial Council of Agricultural Research at the cold storage plant specially put up for the purpose at Kirkee and the results obtained during the last three years from 1936–39 have now been published (Karmarkar and Joshi in *Misc. Bull.*, No. 45 of the I.C.A.R.). The following are the important conclusions: (1) Potatoes can be kept without sprouting at 35° F. almost indefinitely. At temperatures higher than 35° F. potatoes begin to sprout; at 40° F. they remain dormant for varying periods, the length of which depends on the time that elapses from harvest to storage; for instance if the tubers are put in immediately after harvest they can remain dormant for quite nine months. At 35° F. and 40° F. the tubers remain in sound condition without any kind of rotting. Lower temperatures of 30° F. and 32° F. bring about "black-heart" disease with a characteristic hollow cavity in the interior of the tuber. (2) The germinating power of the tubers is not impaired by cold storage at 35° F. and 40° F. Such tubers sprout vigorously when removed to 68° F. without any rot setting in. (3) Losses in weight due to driage are largely reduced; at 35° F. and 40° F. the loss of tubers stored in crates or gunny bags was only five per cent. after five months at 40° F. and after nine months at 35° F. (4) In potatoes stored at 30° F. and 35° F. there is a marked accumulation of sugars so that the tubers become sweet and to that extent suffered in quality as table potatoes. If removed to 68° F. the tubers lost some of this sweetness and therefore somewhat improved in quality.

It will thus be seen that cold storage can be used as a very efficient method as far as seed potatoes are concerned, while in respect of table potatoes it has the drawback of impairing the quality to some extent. Such as they are the results are of great and undoubted practical value. There are now cold storage facilities in many large potato centres such as Jammu, Karachi, Meerut, Patna and Sialkot, and a knowledge of these results should lead to a larger use of these facilities by seed potato merchants. A. K. Y.

Infantile Cirrhosis of the Liver.—An important paper on the ætiology, pathology and morbid anatomy of the liver in infantile cirrhosis, has appeared in the *Proc. Ind. Acad. Sci.* (1941, 14, 310). According to the author there are two factors in the ætiology of the disease: cow's milk and *B. coli* infection. Cow's milk brings about the predisposing factor, *viz.*, gastrc-intestinal disorder and devitalization of the liver and *B. coli* the cirrhotic changes in the liver. In support of the view that *B. coli* is the causative agent, the author states that (1) smears of liver substance show the presence of gram negative bacilli morphologically identical with *B. coli*, (2) cultures made from the scrapings of the liver substance show the presence of *B. coli communis*, (3) cultures of urine in 4 cases have shown the growth of *B. coli*, and (4) vaccine prepared out of *B. coli* grown from the fæces of children suffering from infantile cirrhosis and inoculated in successive increasing doses over a period of 6–7 weeks, has cured the disease.

Quality of Hides and Skins.—Under the auspices of the Imperial Council of Agricultural Research, attempts are being made to improve the quality of hides and skins by preventing the damage caused by warble flies and ticks and by improving the methods of flaying and curing. Warble fly is prevalent, especially in the drier tracts of Northern India, and even at a conservative estimate the annual monetary loss to the whole country due to small permanent holes in the skin caused by the grubs while escaping to the exterior from warble tumours on the back, is about Rs. 1,50,00,000.

The life-history of the ox warble fly has been completely worked out under Indian conditions at the Imperial Veterinary Research Institute, Muktesar, and the preliminary results of the work carried out in collaboration with the Civil Veterinary Department, Punjab, on evolving effective and cheap control measures by preventive and dressing methods in the field appear to be promising.

Similar work on goat warble fly prevalent especially in hilly tracts is also in progress. A study of the various ticks, their life-history, damage caused by them to hides and skins and their control by biological methods, and suitable dips at appropriate intervals are also being taken up at the Imperial Veterinary Research Institute with the Council's assistance.

Work carried out so far in the Bombay Presidency under another scheme financed by the Council, has shown that cattle dips prove useful in controlling the ticks and tick-borne diseases and thereby improving the condition of the animals and the hides. A scheme has been approved by the Council for establishing village flaying centres in the North-West Frontier Province in order to improve the flaying and curing of hides.

Quality in Wool and Sheep Breeding.—A number of co-ordinated schemes of sheep breeding financed by the Imperial Council of Agricultural Research are in progress in various Provinces and States, namely, Punjab, Bombay, Madras, Bihar, Mysore and Kashmir.

The sheep are graded and selected for breeding on the basis of the quality of wool and in order to do this an analytical laboratory is being added to each field station, and a special laboratory, to work in consultation with the woollen industry, has been provided at the Bombay University.

A scheme has recently been approved by the Advisory Board for the establishment of village shearing and grading centres in the North-West Frontier Province in order to demonstrate to and popularise among the village shepherds washing of sheep before clipping, improved methods of shearing and classification of wool.

A scheme for the establishment of a Central Wool Research Station at the Imperial Veterinary Research Institute, Izatnagar, has also been under the consideration of the Council for some time. There is unanimity of opinion that early establishment of such a guiding and correlating organization is essential for the scientific improvement and development of the wool industry in this country. The Advisory Board of the Council has, therefore, strongly recommended to the Government of India to finance this scheme as early as possible.

New Uses for Jute.—According to a press note dated November 20, issued by the Indian Central Jute Committee, Mr. D. L. Mazumdar, I.C.S., Secretary, Indian Central Jute Committee, recently visited the Lac Research Institute of the Indian Lac Cess Committee at Namkum (Ranchi), and discussed with Dr. H. K. Sen, the Director of the Institute, the possibilities of extending the use of jute.

Two promising lines of investigation received particular attention, *viz.*, the use of jute cloth in combination with jute waste for the manufacture of cheap laminated boards and other similar purposes, and the treatment of jute fibre with suitable solutions of shellac resin as a basis for the manufacture of different types of 'proofed' material.

The application of synthetic plastics to jute is another allied and very important line of investigation which is already receiving the attention of the Central Jute Committee. Consultations with Dr. Sir S. S. Bhatnagar of the Board of Scientific and Industrial Research on this subject are already in progress, and a detailed scheme of work is likely to be formulated in the very near future.

Progress of Higher Education in British India.—The total number of arts colleges in the whole of British India, both for men and women, rose from 289 in the previous year to 304 in 1939–40 according to the latest survey of progress of education in British India. The number of men under instruction rose from 100,770 to 109,921, showing an increase of 9,151. In the case of women, scholars in arts colleges in the previous year numbered 7,976 and in 1939–40 they were 9,615, showing an increase of 1,639.

The number of professional colleges increased by two, from 79 in 1938–39 to 81 in 1939–40. The total number of men under instruction also went up by 1,593 and of women by 92.

The total educational expenditure in 1939–40 was Rs. 29,08,76,000 as compared with Rs. 27,81,99,000 during the previous year. The share of public funds in the increased expenditure was to the extent of Rs. 79,17,000, of fees Rs. 46,35,000 and of other sources, which include private benefactions, Rs. 1,25,000.

Coal Mines Stowing Board.—The annual report of the Board for the year 1940–41 which has been recently published, gives an account of the way in which the work of the Board has been organised to fulfil the functions assigned to it, according to the Coal Mines Safety (Stowing) Act of 1939—particularly the granting of assistance from the funds for the following purposes: (i) for stowing or other protective measures which are required to be undertaken by an order issued by the Mines Department under Section 9(3) of the Act, (ii) for any protective measures essential for the effective prevention of the spread of fire to, or the inundation by water of, any coal mine from an area adjacent to it, (iii) for stowing operations voluntarily undertaken in the interests of safety, and (iv) for research connected with safety in mines. The first problem which engaged the attention of the Board was that connected with the fire areas in the Jharia coal field, and a number of protective measures have already been adopted in these areas. As many as 68 applications were received from a number of companies for financial assistance from the Board, and a special *ad hoc* expert technical committee was appointed to deal with them.

Department of Fisheries (Hyderabad State).—A three-year scheme for the development of the Fishery Resources of the State, has recently been sanctioned by the Government. The services of a Zoologist from the Osmania University, who has since undergone training in the Madras Fisheries Department, have been obtained for starting this Department. He is assisted by four technical assistants.

During the initial stages, the work will be largely exploratory. The following problems are now engaging the attention of the research staff: (1) Fish survey of the main rivers and tanks, (2) Possibilities of establishing fish farms and hatcheries for the breeding of useful fishes and prawns, and (3) Problems of transport and marketing of fish and prawns.

Indian Chemical Manufacturers Association.—The third annual meeting of the Indian Chemical Manufacturers Association was held in Bombay on the 19th and 20th September 1941. The first two annual meetings were held in Calcutta and it is a matter for gratification that the venue was changed this year. It is to be hoped that next year's meeting will be held in Madras or some other South Indian city. The session was presided over by Raj Mitra B. D. Amin, the outgoing President of the Association. As usual, a number of

resolutions were passed, most of them unanimously, on subjects of importance to the Indian Chemical Industry such as excise regulations, the refusal of the Government to permit opium alkaloids to be manufactured by private firms, the activities of the Government Medical Stores Depots, the heavy railway freight on raw drugs and medicines, the failure of the Government to appoint a representative of the Indian Chemical Manufacturers on the Drugs Technical Advisory Board, etc. The efforts of the Association deserve better success than they have had hitherto; so far it has been chiefly a cry in the wilderness, though a very loud and persistent one.

Under the auspices of the Association, a conference of manufacturers and representatives of universities and research institutions was held under the presidency of Dr. Jivraj Mehta with the object of considering steps to secure closer co-operation and collaboration between manufacturers and research institutions. After some discussion a sub-committee was appointed to recommend suitable steps to be taken to further the objects of the conference.

Mr. J. N. Lahiri of the Bengal Chemical and Pharmaceutical Works was elected President of the Association for the year 1941–42. The membership of the Association has been increasing steadily and its usefulness is growing.

SEISMOLOGICAL NOTES

During the month of November 1941 three great, four moderate and six slight earthquake shocks were recorded by the Colaba seismographs as against one great, one moderate and six slight ones recorded during the same month in 1940. Details for November 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of focus	Remarks
November 1941		H.	M.	(Miles)		(Miles)	
5	Moderate	23	9	3430	Lat. 10°·5 N., Long. 124° E., near Leyte in the Philippine Islands.		
6	Slight	12	36	5230			
9	Great	5	8	3550	Lat. 5°·5 N., Long. 124° E., near Mindanao, Philippine Islands.		
9	Slight	15	27	1360			
12	Slight	12	21	1710	Lat. 6° N., Long. 95° E., in the neighbourhood of Sumatra.	60 (approx.)	
12	Slight	15	35	2500			
18	Great	22	17	3750	Lat. 32°·3 N., Long. 133° E., within 100 miles to the south of the island of Shikoku, Japan.		
21	Slight	1	25	1490	South of the Andaman Islands.		
24	Slight	22	7	4550			
25	Moderate	3	20	7250			
25	Great	23	34	5370	Lat. 43° N., Long. 19° W., in the Atlantic Ocean to the northwest of Portugal.		Felt in Portugal.
27	Moderate	14	8	3590		190 (approx.)	
28	Moderate	17	53	1280	The Hindukush Mountains.	125 (approx.)	Felt in Peshawar.

MAGNETIC NOTES

November 1941 was more active than the previous month. There were 13 *quiet* days, 13 days of *slight* disturbance and 4 of *moderate* disturbance as against 7 quiet days, 15 days of slight disturbance and 8 of moderate disturbance during November 1940.

The day of largest disturbance during November 1941, was the 28th when a moderate disturbance was recorded. The quietest day was the 14th. The characters on individual days were as follows:—

Quiet days	Disturbed days	
	Slight	Moderate
2, 4, 12–16, 20, 21, 24–26, 30	3, 5,7–11, 18, 19, 22, 23, 27, 29	1, 6, 17, 28

Only one moderate disturbance was recorded during November 1941, as against three moderate storms in November 1940. The mean character figure for November 1941 was 0·70 as compared with 1·03 for the same month last year.

M. R. RANGASWAMI.

ASTRONOMICAL NOTES

The Earth will be in perihelion at $0^h\ 30^m$ I.S.T. on January 3, 1942.

Planets during January 1942.—Venus continues to be a brilliant object in the western sky in the early part of the night; it will be gradually approaching the Sun and on January 11 will be at a stationary point of its geocentric orbit. Mercury will likewise be an evening star, but can be seen only during the latter half of the month, low down near the western horizon at about sunset; it reaches greatest elongation from the Sun (18° 31′ E.) on January 25. Mars is moving slowly eastwards in the constellation Aries and will be near the meridian at sunset; its brightness is steadily decreasing and will be little more than that of an average first magnitude star by the end of the month.

Both Jupiter and Saturn are conspicuous objects in the eastern sky in the early hours of the night and will be on view until their setting about a couple of hours after midnight. The ring ellipse of Saturn is now seen fairly widened, the angular dimensions of the major and minor axes being 43″·5 and 16″·8 respectively. Uranus continues to move slowly in a retrograde direction in the constellation Taurus about six degrees to the south east of the star cluster Pleiades. There will be a very close conjunction of Neptune with the Moon on the night of January 8; an occultation of the planet will occur at about moonrise that night which will be visible wholly or in part in this country, but a binocular or a small telescope will be necessary to observe the phenomenon.

T. P. B.

ANNOUNCEMENTS

The Indian Statistical Conference.—The Fifth Session of the Indian Statistical Conference will be held at Baroda during the first week of January 1942, in co-operation with the Indian Science Congress. His Highness the Maharaja Gaekwad of Baroda has kindly agreed to open the Conference at 9-30 A.M. on 3rd January 1942. There will be discussions and reading of papers in different branches of theoretical and applied Statistics, and it is hoped that joint meetings with allied sections of the Science Congress will also be arranged.

The Government of India, the different Provincial Governments, many of the important Indian States and Universities in India have given official recognition to the Conference and are expected in many cases to send delegates. Enquiries in regard to local arrangements and accommodation should be addressed to Mr. A. C. Mukherji, Director of Statistics, Baroda.

Indian Statistical Institute.—In accordance with a resolution adopted at the fourth Indian Statistical Conference, held at Benares on the 4th January 1941, a questionnaire has been circulated to statisticians all over the country, with a view to invite suggestions on the organisation of statistical education in India on a really comprehensive and systematic manner. "In the questionnaire attempts have been made to focus attention on the aims and requirements of statistics with a view to organise the teaching of statistics in its present setting and with an eye to its future development. Among other things also, the question of opportunities of useful employment of statisticians by Government and other institutions has been considered."

It is proposed to present an analytic summary of the replies received at the Fifth Session of the Indian Statistical Conference to be held during the first week of January 1942, at Baroda, for further consideration. Persons interested in the subject are invited to participate in the discussion.

Lucknow University.—Programme of Science Lectures for the Winter Session (1941–42):—

January 9 and 10.—Prof. S. R. Bose, D.SC., F.R.S.E., "The Polyporaceae: (*a*) Anatomical and cytological studies. (*b*) Physiological studies."

January 12 and 13.—Dr. B. Mohan, M.A., PH.D., "Self-reciprocal functions".

January 16 and 17.—Dr. R. S. Varma, D.SC., "Recent developments in the theory of integral functions".

January 23 and 24.—Dr. Ram Behari, M.A., PH.D., "Differential geometry of ruled surfaces".

January 30 and 31.—Dr. A. C. Chatterji, D.SC., DR.ING., "Supersaturated solutions".

February 4 and 5.—Dr. A. N. Singh, D.SC., "The problem of integration".

February 7.—Prof. N. N. Sen Gupta, M.A., PH.D., "Dimensional conception of mental life".

February 14.—Mr. S. B. L. Mathur, M.SC., "Halo or corona—a problem in optical meteorology".

February 18 and 19.—Dr. D. N. Majumdar, M.A., Ph.D., "Blood Groups: (*a*) Distribution of blood groups in India. (*b*) Blood groups of criminal tribes in the United Provinces".

February 22 and 23.—K. Ramiah, "Plant breeding and genetics in India".

Indian Research Fund Association.—The attention of our readers is drawn to an advertisement appearing elsewhere in this issue, inviting applications for five Research Fellowships of the value of Rs. 150 each per mensem under the Indian Research Fund Association. Applications should reach the Secretary, I.R.F.A., Secretariat, New Delhi, not later than 7th February 1942.

Erratum.—*Vol.* 10, *No.* 11, *Nov.* 1941: Note entitled "Industrial Research Fund," page 483, second column, line 14, *for* "prominent" *read* "permanent".

We acknowledge with thanks, the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4595–96.
"Journal of Agricultural Research," Vol. 63, Nos. 2–3.
"Agricultural Gazette of New South Wales," Vol. 52, Pt. 10.
"Indian Journal of Agricultural Science," Vol. 11, Part 5.
"Biochemical Journal," Vol. 35, Nos. 5 and 6.
"Journal of Chemical Physics," Vol. 9, No. 10.
"Journal of the Indian Chemical Society," Vol. 18, No. 8.
"Experiment Station Record," Vol. 85, No. 3.
"Electrotechnics," No. 14, Nov. 1941.
"The Indian Forester," Vol. 67, No. 12.
"Transactions of the Faraday Society," Vol. 37, No. 9.
"Indian Farming," Vol. 2, No. 11.
"Geological, Mining & Metallurgical Society of India, (Jl.)," Vol. 13, No. 2.
"Bulletin of the Health Organisation (League of Nations)," Vol. 9, No. 3.
"Review of Applied Mycology," Vol. 20, Pt. 9.
"Bulletin of the American Meteorological Society," Vol. 22, No. 7.
"Journal of Nutrition," Vol. 22, No. 4.
"Nature," Vol. 148, Nos. 3748–52.
"Philippine Journal of Science," Vol. 75, No. 5.
"Journal of Research (National Bureau of Standards)," Vol. 27, No. 3.
"Canadian Journal of Research," Vol. 19, No 8.
"Sky," Vol. 5, No. 12.
"Science and Culture," Vol. 7, No. 6.
"Indian Trade Journal," Vol. 143, Nos. 1847-50.

BOOKS

"The Ecology and Control of the Forest Insects of India and the Neighbouring Countries," by C. F. C. Beeson. (Forest Research Institute, Dehra Dun), 1941, pp. ii + 1007.

"Galois Lectures" delivered by Jesse Douglas, Philip Franklin, Cassius Jackson Kenyser and Leopold Infeld. (Scripta Mathematica, New Yerk), 1941, pp. 124, price $1.25.

"An Introductory Course in Quantitative Pharmaceutical Analysis," by M. L. Schroff. (Indian Pharmaceutical Association, Benares Hindu University), 1941, pp. x + 312, price Rs. 4 or $1·75.

"An Introduction to Semi-Micro Qualitative Analysis," by M. L. Schroff and G. P. Srivastava. (Indian Pharmaceutical Association, Benares Hindu University), 1941, pp. x + 203, price Rs. 3 or 5*sh.*

"Plant Science Formulæ," a reference book for Plant Science Laboratories (including Bacteriology), by R. C. McLean and W. R. Ivimey. (Macmillan & Co., London), 1941, pp. vii + 203, price 7*sh.* 6*d.*

"Diffusion in and through Solids," by Richard M. Barrer. (Cambridge University Press, London), 1941, pp. xiii + 464, price 30*sh.*

"The Applications of Chemical Engineering," Edited by Harry McCormack. (Chapman & Hall, London), 1940, pp. x + 431, price 21*sh.*

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

November 1941. SECTION A.—Sir C. V. Raman: *The thermal energy of crystalline solids: Basic theory.* The bulk of the thermal energy is associated with the lattice frequencies properly so-called which appear as monochromatic lines in the infra-red spectrum. The residue is associated with superlattice frequencies of different orders which are also monochromatic. These frequencies appear in the remote infra-red region and their contribution to the specific heat is relatively important only at low temperatures. The spectroscopic evidence is in full accordance with these ideas. The specific heat theories of Debye and Born are based on assumptions which are theoretically unjustifiable, and in contradiction with the experimentally observed behaviour of crystals. R. Norris: *The thermal energy of crystalline solids: White phosphorus.* Bisheswar Dayal: *The thermal energy of crystalline solids: Lithium, tungsten, gold, silicon and grey tin.* V. B. Anand: *The thermal energy of crystalline solids: Diamond.* Experimental studies have shown that the lattice spectrum of diamond consists of monochromatic frequencies down to much below the limiting frequency of Debye. Excellent agreement is obtained between the spectroscopic values and the experimental data throughout the temperature range covered by Pitzer and indeed precisely in the region where the values given by the Debye formula show the largest deviations from the observed ones. Bisheswar Dayal: *The thermal energy of crystalline solids: Magnesium, zinc and cadmium.* R. Norris: *The thermal energy of*

crystalline solids: Quartz. C. S. VENKATESWARAN: *The thermal energy of crystalline solids: Alkali halides.* A general expression is derived for the thermal energy of cubic crystals of the rock-salt type in terms of the lattice and superlattice frequencies and evaluated for rock-salt and sylvine. Calculated values are in reasonable agreement with the experimental data. R. D. DESAI, R. F. HUNTER AND G. S. SAHARIYA: *Studies in the cyclohexane series. Part V. The isomeric* 1-*carboxy*-4-, *and* 3-*Methylcyclohexane*-1-*a-benzylacetic acids.* K. V. KRISHNA RAO: *Raman spectrum of mercuric chloride in relation to its structure.* $HgCl_2$ should be non-polar and therefore a linear molecule. K. VENKATESWARLU: *Effect of temperature on the intensities of Raman lines. Part I. Crystals.* Sharp disagreements with the existing theories have been noticed in the matter of the individual intensities of the Stokes and the anti-Stokes lines at different temperatures, but the observed ratio of the intensity of the Stokes lines to that of the anti-Stokes lines conforms to the present theories. HIRALAL SHRIVASTAVA: *Physico-chemical studies with aqueous fluoride solutions. Part I. The decomposition and discharge potentials of some fluorides in aqueous solution.* S. RANGASWAMI AND T. R. SESHADRI: *Fixation of aromatic double bonds.* BAWA KARTAR SINGH AND SAILESH CHANDRA SEN: *The kinetics of the mutarotation of aminomethylene-d-camphor.* HIRA LAL DUBE AND SATYA PRAKASH: *Kinetics of sol-gel transformation. Part V. The influence of different coagulating electrolytes on the setting of ferric phosphate gel.* S. RAMACHANDRA RAO AND MISS K. SAVITRI: *Magnetism of strontium.* G. V. L. N. MURTY AND T. R. SESHADRI: *Raman effect and hydrogen bonds. Part I. Mixtures of esters and acceptor molecules.* Hydrogen bond formation between various esters as donor molecules and phenol, alcohols, and chloroform as acceptor molecules has been studied. There are large variations in the strengths of the hydrogen bonds.

SECTION B.—P. N. KRISHNA AYYAR: *The biology and distribution of the parasites of the cotton stem weevil,* Pempheres affinis *Fst. in South India.* B. G. L. SWAMY: *The development of the male gamete in* Cymbidium bicolor *Lindl.* M. J. THIRUMALACHAR AND K. BASHEER AHMED KHAN: *Megasporogenesis and endosperm formation in* Eriodendron anfractuosum *D.C.* M. J. THIRUMALACHAR: *A new species of puccinia on* Ocimum adscendens. T. S. RAGHAVAN AND A. R. SRINIVASAN: *Cytomorphological features of* Portulaca tuberosa *Roxb.*

Royal Asiatic Society of Bengal:

August 4, 1941.—D. N. MAJUMDAR: *Racial Affiliation of the Gonds.* Anthropometric measurements of about 600 people were taken by the author and the statistical data were analysed with the help of the Statistical Laboratory, Calcutta. The analysis reveals a close correspondence between social units and racial status. The following conclusions have been drawn from the anthropometric survey of Bastar State: (1) The Gonds represent a blended racial type. (2) The higher castes, Dhakars and Halbas of Bastar have freely mixed with the Gond tribes in the neighbourhood. (3) The Hill Marias who are the most primitive cultural group in Bastar differ from the higher caste groups. (4) The Dandami Marias who were originally Hill Marias have come in closer contacts with the higher castes. (5) From a comparison of the head measurements, it appears that there is a progressive lengthening of the head towards the mountain regions.

Society of Biological Chemists (India):

Addressing the *Society of Biological Chemists, India* (Madras Branch), on the 15th November 1941, Dr. Fowler dealt with recent developments in the utilisation of Town's waste for war-time food production, representing a fundamentally important aspect of war effort. The campaign of "The Dig for Victory" directed towards making England self-supporting as far as possible in the matter of food, is now in full swing in that country, and this movement has brought some 2 million acres of fresh land under the plough. To reap the maximum harvest from all this and other agricultural land, the question of fertilisers has first to be considered, and the problem has caused attention to be given to the whole cycle involved, *i.e.*, the land and its fertility, the crop and its quality, the preparation and consumption of food from the crop, and the return of the consequent waste back to the soil.

The waste products of the town—both the liquid and the solid—were now being scientifically treated to yield valuable food producing fertiliser and Dr. Fowler drew attention to an interesting discussion on the whole subject which took place last March before the Royal Society of Arts. In the course of this discussion, the importance of the conservation of the humus of the soil, was emphasised. The formation of humus from organic matter was an aerobic process and this could be speeded up by scientific "composting" which facilitates the process of oxidation. The object of this was to prevent what might be termed "soil indigestion". The potential fertilising material in the compost heap was fermented separately from the soil so that the products of fermentation were at once available to feed the crop.

Dr. Fowler emphasised the importance of organic manures which imparted to the crops a "quality" not obtainable from artificial fertilisers. In support of this contention, the lecturer drew attention to the researches of McCarrison and his colleagues. He pleaded for a thorough and scientific utilisation of waste in India.

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